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INFLUENCE OF SMOKE AND ETHYLENE ON THE FRUITING OF THE PINEAPPLE (ANANAS SATIVUS SHULT)*

ANTONIO G. RODRÍGUEZ,

The pineapple is one of the principal export crops of Puerto Rico. The large crop months are May, June and July. These unfortunately, are the peak months for the Cuban crop. As might be expected, therefore, there are times when the American market receives more pineapples than can be profitably sold. If the season of production of pineapples could be extended so that a larger proportion of the fruit could be ready for the American market in advance of the usual time, the economic situation would be improved. It was with these ideas in mind that this investigation was undertaken.

An immediate stimulus to the direction of this investigation was the fact that one of the important growers in Puerto Rico was shipping his pineapples to the American market some months in advance of the other growers. From observations and from discussions with this grower and others, it appeared, that the only departure in cultural methods made by this grower was the use of smoke to hasten the flowering of the pineapple. In practice this grower covers a small part of the pineapple field with a tent of loose cloth. Within this tent smudge fires are provided and smoke production allowed to continue for twelve hours. Flower and fruit production follow in a shorter period of time than usual.

Assuming these as facts, consideration was given to the possible stimulating agent in the smoke responsible for this rapid forcing of the plants. From the fact that ethylene is produced in destructive distillation of wood and that ethylene has been found to be effective as a forcing agent, it seemed logical to test not only the smoke but to modify the practice so as to include treatment with ethylene gas. An added incentive to determine the possible influence of smoke and ethylene gas was the recognized practice of the use of smoke in certain areas in the Philippine Islands to force the Mango tree into flower.

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This practice of smoking the Mango tree (*Mangifera indica* Linn.) has been described by González (**5**). Smudges are built on the ground, under the trees, a few meters from the trunk. These smudges consist of conical piles of light combustible material, with a cover of moist or green grass on the top. When ignited, these smudges produce a dense smoke, under which condition the trees are kept until flowering is attained.

Recently, in the island of Puerto Rico the smoking of pineapple plants to hasten the flowering has become a practice among certain growers. A portion of the field is covered with a tent as earlier described, and within this tent between the rows of pineapples, smudge fires are made; the plants being exposed to the influence of the smoke for a period of not less than twelve hours. Flower production was claimed to have been attained shortly afterwards. The origin of this practice is not yet known.

Molisch (**10**), (**11**), (**12**), Knight and Crocker (**7**), (**8**), and Bokerny (**1**) have studied the influence of smoke on plants.

Contrary to the results obtained in the Philippines and in Puerto Rico, these investigators have reported that smoke derived from the burning of tobacco, paper, straw and wood, is toxic to many plants. This suggests that the quantity of smoke per unit volume of air and the physiological state of the plant are factors of importance.

In order to make clearer the character of this investigation it seems desirable to inscribe briefly the cultural methods used in Puerto Rico. The variety Red Spanish is the most extensively grown pineapple. The popularity of the Red Spanish is due to the fact that it produces abundantly and the fruit has excellent shipping qualities. The propagation of the pineapple plant is accomplished by means of slips, suckers and crowns. Slips are shoots that originate from the buds produced at the base of the fruit. Suckers develop from the axils of the leaves, while crown slips originate at the upper end of the fruit.

Among growers in Puerto Rico slips are more popular as propagating material than suckers. It is commonly believed that suckers will produce only two crops while slips will give three crops. From suckers, a crop is obtained at the end of fourteen to sixteen months, while from slips eighteen months are required. To growers this advantage of early production is not sufficient to offset the disadvantage of the sucker producing only two crops.

The propagating material may be planted at any time of the year, but spring and summer planting is preferred by growers. Root development may begin shortly after planting but generally speak-

ing new leaf development is not apparent until five to six weeks after planting. Under favorable conditions, particularly with an adequate water supply, leaf development may occur sooner.

Normally, suckers will flower at the end of ten to thirteen months. Slips require fourteen to sixteen months to flower. With both there are irregularities, some plant flowering ahead of the usual period. Whether such unusual behavior is due to the stage of maturity of the slip when planted or to the soil and weather condition, is not yet known.

EXPERIMENTAL

The use of smoke to force pineapple plants into fruit production is a practical development. No controlled experimental work has been reported of this practice. For this reason it seemed desirable to determine the influence of smoke under controlled conditions.

In considering the cause of flowering of the pineapple plant following the treatment of smoke, the primary hypothesis raised was that smoke forces the pineapple plant out of a dormant condition. However it was recognized that some constituents of smoke probably ethylene might effect metabolic changes even though the plants were not in a dormant condition, which changes might conduce to floral development.

Both slips and suckers are completely developed plants. The roots at the time of planting are very short. The fact that new leaf development is retarded four to six weeks after planting suggests that slips and suckers are in a state of dormancy. It seemed probable that the use of ethylene on these might bring about an immediate resumption of growth with a consequent shortening of the time for flower production. There also remained the possibility as was realized, of a more pronounced effect of ethylene on fruit production. Accordingly an experiment was devised in which both slips and suckers were exposed to ethylene previous to planting. Such a method, if it proved successful, would obviously be a cheaper and more practical method than the use of smoke under field conditions.

I. USE OF SMOKE UNDER FIELD CONDITIONS

In these particular experiments, consideration was given to the influence of different quantities of smoke and to the effect produced as influenced by the age of the plants.

The plots for experimental purposes were selected in a field at Isla Verde, Santurce, Puerto Rico. The plants were normal in appearance and growing in a soil which consists of a fine sand under-

laid by a stratum of heavy clay impervious to water. The top five inches contained an abundance of organic matter. The soil is low in calcium, phosphorus and potassium. Natural drainage is poor and consequently artificial drainage is essential. This was provided. In general it may be stated that the soil is not well suited for crop production. To obviate variations in the plots due to soil conditions, sections were selected in the field for uniformity of soil and plants.

Each plot was one-fifth acre in area and had approximately 2,000 plants. Each plot comprised twelve rows of plants. A tentlike structure about four feet in height was constructed over each plot. The cloth used was of a loosely woven cotton, a low grade muslin. The material used to produce the smoke was placed in cans of five gallons capacity and placed within the tent. The smoke was produced by a slow combustion of the dry husk of the cocoanut fruit together with the green bud scales of the cocoanut palm. The dry husks were slightly moistened. The fuel was renewed several times during the treatment. Combustion was slow with a low flame and producing a large amount of smoke. The smoke diffused through the meshes of the cloth. The duration of the treatment was twelve hours, usually from 6 P. M. to 6 A. M.

Experiment I

In this experiment the plants to be treated had been planted seven months previously. On December 1, 1930, twelve cans were placed within the tent and the plants exposed to the smoke for a period of twelve hours.

By the latter part of December 1930 the favorable effect of smoke was apparent by the development of red pigment in the lower part of the leaves near to the growing point. This change is recognized as an indication of the flowering period. By January 3, 1931, the flower stalk had appeared and by the end of January the fruit was well formed. The fruits produced by treated plants were mature and harvested in March 1931. The fruits obtained from the controls were harvested two months later. Practically every plant in the treated plots responded to the smoke treatment. The fruits were of marketable size and of quality equal to the fruit produced by untreated plants. The even bearing of the treated plants is shown in figure 1.

Plants adjacent to treated plots and which were under the influence of the smoke diffusing out of the tent also flowered.

One of the treated plots in this experiment did not flower. It was found, however, that the laborers had not given proper attention to the fires and the plants received only an eight-hour treatment.

Experiment II

An entire section of pineapple field, which had not flowered after twenty months of growth, was selected to test the influence of smoke in forcing plants to flower. Sections of two thousand plants each was covered with a tent and smoked for a period of twelve hours. The concentration of the smoke within the tent was increased by using twenty cans of the burning material.

Flowering was noted six weeks after the smoke was applied. Through a misunderstanding, the entire field was treated and no controls left. It was noted, however, that the plants showed no signs of approaching flowering at the time of treatment. As stated previously, when the pineapple plant is near to the flowering period, the lower part of the inner leaves near to the growing point becomes red. This coloration usually appears approximately eight weeks before flowering. Such signs were not observed in this section prior to the treatment, and from the fact that all plants flowered and fruited at the end of six weeks, after treatment, it is probable that the smoke was effective.

Experiment III

In the third experiment, plants which had already given one crop of fruit and which were about twenty-four months old were treated with smoke for twelve hours in the usual way. The experiment was varied so as to include different concentrations of smoke. Such concentrations were adjusted by using different numbers of cans producing the smoke. Sections were provided in which 8, 12, 16 and 20 cans of the burning material were used respectively. The plants were treated on November 24, 1930. Normally these plants would not have flowered until late in February. By treating them with smoke regardless of the number of cans used to produce the desired concentration, all flowered early in January, six weeks after the treatment. Sections left as checks had not flowered up to April 1931. The experiment is still in progress.

II. TREATMENT OF SLIPS AND SUCKERS BEFORE PLANTING WITH ETHYLENE AND SMOKE

Since ethylene is a product obtained during destructive distillation of wood, and since it has been used as a forcing agent in the

fields of Floriculture, Pomology and Vegetable Crops it was also tried as a forcing agent for pineapple cuttings with a view to developing a better method than the smoke treatment.

Mature slips and suckers were placed in a closed room and ethylene gas applied in two different concentrations, one part of gas to eighty parts of air (1: 80) and one part of gas to two hundred parts of air (1:200). Gas was supplied every day at eight o'clock in the morning and at six in the afternoon. The room was ventilated for about half an hour before a new application of gas. These treatments lasted one week, at the end of which time slips and suckers were planted and observations of growth and development of roots were made. Checks were held as close to the same conditions of temperature humidity and light as could be obtained. A larger number of slips were used because they are preferred by planters as propagating plants.

The treated slips and suckers were planted August 16, 1930 in the experimental plots of the Insular Experiment Station of Puerto Rico. The number of plots and treatments are as follows:

6 plots of slips—1: 80 treatment
6 plots of slips—1: 200 treatment
4 plots of suckers—1: 80 treatment
3 plots of suckers—1: 200 treatment
3 plots of slips untreated—controls
3 plots of suckers untreated—controls

Each of these plots contains twelve plants. The control plots were scattered among the treated plots as can be seen from Table I.

Smoke was also used on slips before planting. They were placed in a closed room and treated with smoke for a period of ten hours. The smoke was obtained from smudge fire built in the same room. Wood was used as the combustible material to produce the smoke. This material was covered with green grass and sand to insure slow combustion.

For plants treated with ethylene and smoke before planting, no fertilizers were used. The plants were left entirely to develop with the natural fertility of the soil.

I. RESULTS

The slips and suckers treated with ethylene were planted August 16, 1930. The treated slips were turning yellow and appeared more dry than the controls at the time of planting, especially the ones to which the high concentration of the gas had been given. The young plants were favored by rain during the first and second weeks after

planting. Controls and treated plots showed no difference in root development or growth during the first weeks. In general the control plants appeared more vigorous.

No data on growth were taken until five months later when all treated plants had fruited. These plants had flowered at the end of three months after planting. The results presented here were taken during the last week of January 1931, when many treated plants had well matured fruits. When the fruits were harvested the plants were six months old. Up to this time none of the plants in the control plots had bloomed. The experiment is still in process. By May 1, 1931, nine months after planting only two of the control plants derived from suckers had flowered.

None of the plants which had been exposed to smoke previous to planting showed any appreciable response to the treatment. The smoke-treated plants were in appearance similar to the plants in the control plots. The experiment is still in progress and it remains to be determined if this treatment will prove of value.

The results obtained from the treatment of the slips and suckers with ethylene are of unusual interest. Generally plants from suckers will not flower until nine months after planting while plants produced by slips flower only after thirteen months. With these ethylene treated plants, flowering was noticed three months after planting. Not all of the treated plants had produced fruits by February 1931. These results are presented in Table I. It is not yet possible to state definitely the flowering dates of the untreated plants, but it may be stated that the treated plants flowered at least six months before the control plants.

These results are significant in one other respect. Generally plants derived from suckers flower before those produced from slips. In this particular experiment the ethylene-treated slips and suckers flowered at the same time. This fact is of special significance as will be developed subsequently. While the plants derived from slips flowered as soon as the suckers the latter produced larger fruits. These differences are brought out clearly in Table II and representative fruits are shown in Plate II.

The fruits produced by these treated plants were in general undersize and of no commercial value. It should be remembered that no attempt was made to provide favorable conditions for plant growth by the addition of fertilizers.

TABLE I

NUMBER OF PLANTS THAT PRODUCED FRUIT BY FEBRUARY 1931

Plot No.	Treatment	Number of Plants that Fruited	Number of Plants that did not fruit
1	Ethylene....—1:80. . .Slips	4	8
2	Control.....—..... ..Suckers	0	12
3	Ethylene... —1:200...Slips	9	3
4	Ethylene....—1:80....Suckers	4	8
5	Ethylene....—1:80. ..Slips	4	8
6	Control.....—. . . .Slips	0	12
7	Ethylene ...—1:200...Suckers	6	6
8	Ethylene .. —1:80....Suckers	5	7
9	Control ....—........Suckers	0	12
10	Ethylene... —1:200. .Slips	7	5
11	Ethylene .. —1:200...Slips	6	6
12	Ethylene... —1:80....Slips	5	7
13	Control ...— . Slips	0	12
14	Ethylene .. —1:200 ..Slips	4	8
15	Ethylene... —1:200.. Suckers	5	7
16	Ethylene... —1:80. . Suckers	3	9
17	Control. . —........Suckers	0	12
18	Ethylene ...—1·200 .Suckers	7	5
19	Ethylene....—1:80....Suckers	4	8
20	Ethylene ..—1·80 . .Slips	4	8
21	Control.....— .. .. .Slips	0	12
22	Ethylene.. .—1.200...Slips	5	7
23	Ethylene.. .—1:80.. .Slips	1	11
24	Ethylene ...—1:200. .Slips	6	6

TABLE II

AVERAGE WIDTH AND HEIGHT OF FRUITS PRODUCED BY SLIPS AND SUCKERS

	Slips			Suckers	
	Average Width of Fruit in inches	Average Height of Fruit in inches		Average width of Fruit in inches	Average Height of Fruit in inches
1	1.43	2.31	4	2.93	3.75
3	1 44	2.41	7	3.01	3.91
5	1 42	2 19	8	3.15	3.80
10	1 57	3 43	15	2.45	3.20
11	1.53	2.32	16	3.25	3.66
12	1 75	2.75	18	2 67	3.50
14	1 87	2 62	19	3.17	3.93
20	2.06	2.81	...	...	...
22	2.20	2.85	...	...	...
23	1.00	2.00	...	...	...
24	1.62	2.50	...	...	...
Average	1.62	2.47		2 95	3.67

II. INFLUENCE OF CONCENTRATION OF ETHYLENE ON FRUITING

Slips and suckers as previously stated were given two different treatments with ethylene. One lot was exposed to ethylene at a concentration of one part of gas to eighty parts of air, the second lot was exposed to one part of gas to two hundred of air. The data in Table III suggests at least, that the earlier fruiting was obtained

with the concentration of one to two hundred. This was true for both slips and suckers. The experiments should be repeated before definite conclusions are warranted.

III. INFLUENCE OF CONCENTRATION OF ETHYLENE ON THE SIZE OF THE FRUIT

A comparison was made of the influence of the concentration of ethylene on the size of the fruit. The data show that the size of the fruit was not significantly influenced by the concentration of ethylene. The summarized data are given in Table IV.

TABLE III

INFLUENCE OF CONCENTRATION OF ETHYLENE ON THE NUMBER OF PLANTS THAT FRUITED BY FEBRUARY 1931

Plot No.	Concentration 1:80	Concentration 1:200	Plot No.	Concentration 1:80	Concentration 1:200
1	4		4	4	
3		9	7		6
5	4		8	5	
10		7	15		5
11		6	16	3	
12	5		18		7
14		4	19	4	
20	4				
22		5			
23	1				
24		6			
Average	3.6	6 2		4.0	6.0

TABLE IV

CONCENTRATION OF ETHYLENE ON SIZE OF THE FRUIT ALL PLOTS CONSIDERED

Concentration Ethylene	Slips		Suckers	
	Average width in inches	Average Height inches	Average width in inches	Average Height inches
1:80	1.53	2 41	3.10	3.78
1:200	1.70	2.52	2.72	3.53

OTHER EXPERIMENTS

In addition to the various experiments described in the preceding pages, slips and suckers were shipped to Ithaca in October 1930. These were treated with ethylene, ethylenechlohydrin, dichlorethylene and trichlorethylene at a concentration of 1 : 1000, and planted singly in nine-inch pots in an Ontario Silt Loam. These plants were kept in a greenhouse at a temperature close to 80°F. Unfortunately these

plants have made but little growth under these conditions. A similar lot was brought back from Puerto Rico in February 1931 and treated in a similar manner. Sufficient time has not yet elapsed to permit any conclusions. In Puerto Rico during the month of February new experiments were started with various treatments, both with slips and suckers before planted and with plants under field conditions. These results will be reported at a later date.

Discussion

The use of smoke on plants in the field resulted in a very general flowering of all plants and subsequent early fruit production. The experiments confirm the results obtained in practice by certain growers in Puerto Rico. However, additional experiments are necessary to determine more precisely the essential conditions. The fact that in certain experiments no relation was found between the quantity of smoke used and the response obtained makes it appear probable that there is a wide latitude in this respect. A similar latitude has been noted in the use of ethylene on slips and suckers.

The experiments using ethylene gas on slips and suckers while not yielding uniform results, nevertheless forced plants into flower in about three months instead of after a year or longer. Fruit production was exceptionally early and although the size of the fruit was small it seems possible to increase this by the proper use of fertilizers.

The fact that the ethylene treatment of slips and suckers did not result in a simultaneous flowering of all plants indicates that the physiological condition of these plants must be given consideration in further investigations. From the practical standpoint this failure of uniformity in the time of flowering may be desirable since it enables a longer season for selling fruits.

As yet no analysis have been made to determine the chemical changes occurring in field plants following the smoke treatment, nor for those plants which had been treated with ethylene before planting. González (5) maintained that the effect of smudge fires on the Mango tree (*Mangifera indica,* Linn.) was a temperature effect. Since the fires are maintained for long periods of time temperature may possibly be a factor but at the same time there is a possibility that this forcing effect may be due to the hydrocarbon gases evolved during the combustion. In a slow combustion of wood, straw, or any other organic material there is a destructuve distillation process, in which process various hydrocarbon gases are formed such as acetylene, ethylene, propylene, etc. It is obvious, therefore, that attention must be given to these gases as possible forcing agents.

In the experiments in which the pineapple plants were exposed to smoke under a tent for a period of twelve hours, the combustion was slow and the heat produced was little and could have elevated the temperature but slightly. The temperature increase would be no greater than that commonly experienced during normal conditions. The fact that plants outside the tent, but exposed to the diffusing smoke, also flowered suggests that the constituents of the smoke and not the temperature produced during combustion were responsible for the hastening of the plants into bloom. This view that a gas or gases are the forcing agents is supported by the results obtained from the use of ethylene on slips and suckers before planting.

One other distinct aspect of the problem should be emphasized. Does smoke shorten a resting period in the pineapple? It has been demonstrated that most biennial and perennial plants exhibit a definite resting condition. Thus the question arises: does the pineapple plant enter a period of rest previous to flower production? There is, however, no apparent cessation of vegetative growth before flowering occurs. This suggests that the plant is not in a resting condition. The effect of smoke must, therefore, be to influence metabolism in such a way as to force the meristem into reproductive growth. Harvey (6), Denny (4) and other have demonstrated that ethylene treatments are followed by a conversion of stored food to available food. It is possible that in this experiment with smoke such changes occur in the pineapple with a resulting change in the soluble carbon nitrogen, ratio, which changes might induce flower production.

In support of this view are the results obtained from the treatments of slips and suckers with ethylene. These normally do not produce new leaves until six weeks after planting at the maximum; therefore, the resting condition could not prevail for more than six weeks. On the basis of overcoming the resting condition with ethylene, the time for flower production in the pineapple should have been shortened about six weeks. As a matter of fact the saving in time was more than six months in the more favorable cases. These results point to the conclusion that the ethylene treatment has modified metabolism in such a way as to induce also flower production. This principle, if correct, should prove to be one of paramount importance both for purely scientific as well as from the practical stand-point.

In previous work, except for that of González (5), attention has been given largely to the toxic action of smoke on seedlings. Molisch (10), (11), (12), has shown that tobacco smoke is very toxic to many plants and that smoke produced from paper, straw and wood has the

same effect. On the basis of his data he concludes that carbon monoxide is probably the constituent determining the toxicity of tobacco smoke. Nejubow (13), Crocker (2), (3), Lehman (9), and Knight and Crocker (7), (8), have reported that ethylene is toxic to epicotyls of certain seedlings and to other plant organs. According to Crocker (2), (3), ethylene seems to be the predominant toxic agent evolved during destructive distillation. Bokorny (1) attributes the toxicity of tobacco smoke to the ammonia produced during burning. It is possible that under certain conditions smoke may be injurious to pineapples. In these experiments and in practice the plants are exposed to smoke during the hours of darkness when the stomates are practically closed. Under this condition only a small amount of gases may enter. Perhaps if the smoke treatment were given during the day time, especially in the morning, a much shorter treatment would give the same results.

In future treatments of slips and suckers with ethylene, consideration should be given to humidity and temperature relations. Histological studies to determine the time of flower production should also be made.

In conclusion it should be stated that both smoke and ethylene treatment of slips and suckers hold great promise for controlling the time of fruit production of pineapples. It is probable that under tropical and semi-tropical conditions that these methods may find application for other fruits and flower crops.

SUMMARY

1. The experiments using smoke on pineapple plants in the field confirm the results obtained in practice by certain growers in Puerto Rico. The use of this process in the field resulted in a general flowering of all plants and early fruit production.
2. There was no relation between the quantity of smoke used and the response of plants. This indicates a wide latitude as regards concentration of smoke.
3. The age of the plants was not a factor hindering the effect of smoke treatment.
4. From the results obtained in the smoke treatments and ethylene treatments it seems that one or more constituents in smoke and not the temperature produced are responsible for the hastening of bloom.
5. Under the conditions in which smoke treatments were given to field plants, smoke was not toxic.
6. Large-size fruits were obtained following the smoke treatments.
7. The treatment with smoke previous to planting gave no appreciable response.

8. Slips and suckers treated with ethylene previous to planting flowered six months before the control plants.
9. Fruits obtained from ethylene treatments were undersize. Suckers yielded larger fruits than slips.
10. No significant difference was noted with the several concentrations of gas when used on slips and suckers.
11. The results obtained indicate that the ethylene treatment has modified metabolism and induced flower production.

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ILLUSTRATIONS

Plate I.—Left: Pineapple plants treated with smoke seven months after planting. Right: Control plots.

Plate I.—Representative fruits obtained from slips and suckers treated with ethylene.

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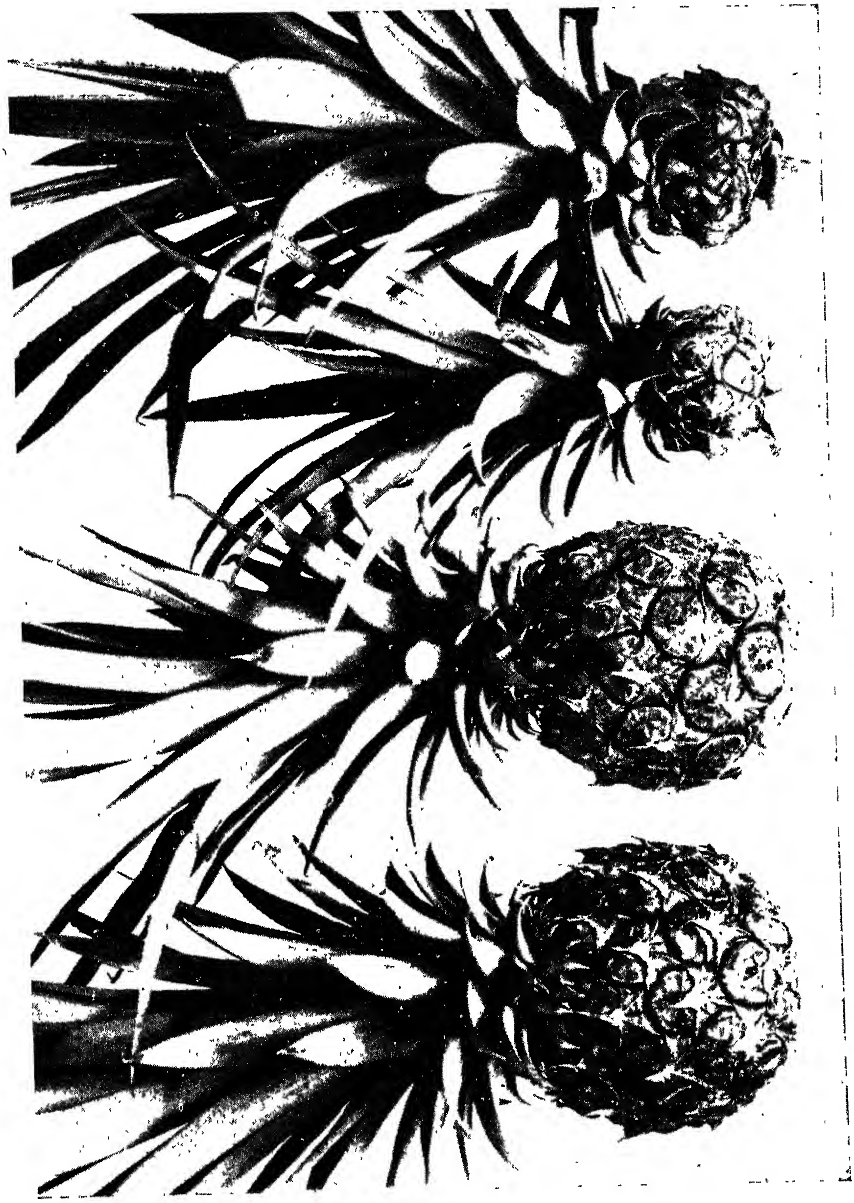
PLATE I.

PLATE II.



INHERITANCE OF COLOR IN THE EGGPLANT

(*Solanum melongena* L)[1]

J. A. B. Nolla[2]

The purpose of this investigation has been to obtain some knowledge of the behavior of color of our so-called native eggplants toward that of the imported Black Beauty and New York Improved as this would be very useful in connection with simultaneous studies on the production through hybridization of eggplants resistant to the bacterial wilt (*Phytomonas solanaceara* (E. F. Sm.) Comm. S.A.B.). The Black Beauty is generally very susceptible to this disease, but it was discovered in preliminary trials by the author in 1923 and 1924 that one of the native varieties was more resistant to the disease than any of the imported varieties. However, this native fruit is of undesirable color and shape for commercial purposes.

The factors which have been studied in this investigation are: color of plant, of fruit and of flower, and the striped character of the anthers.

The first studies on eggplant hybridization seem to have been made by Bailey and Munson (3) and were reported in 1891. The results published then were on the F_1 generation and showed that purple color of both fruit and foliage is dominant over green. In the following year Professor Bailey (2) gave results of some F_2 and backcross data. In a progeny of 175 plants from a self-fertilized F_1 individual he found 83 green and 92 purple plants, a result which would indicate a 9:7 ratio. According to this ratio, two factors should be assumed for color of plant both of which would be necessary for the development of purple color. In the same F_2 population 102 plants came into fruit, 48 of which were colored and 54 green or white. These numbers are contradictory since greens appear to be in excess of purples. It is plain that the numbers were too small to give conclusive results; a larger population would have been more reliable. In two other F_1 fruits A5 and A6, self-pollinated like the preceding one, the results taken together show 299 purple plants to 208 recessive, another indication of a 9:7 ratio.

[1] Presented as a partial fulfillment of the minor requirements for the degree of Doctor of Philosophy at Cornell University.

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In a fourth F_1 fruit (A8), not artificially pollinated nor bagged, the resulting F_2 generation gave 105 purple and 69 green plants. This was presumably naturally selfed although it may have been pollinated by insects. Here again, like the preceding, the results appear to indicate a 9 : 7 ratio for plant color.

In the backcross results conditions are, in a way, different. The backcross progeny of A 2 gave 82 green plants and 21 purples, that of A7 gave 101 greens to 143 purples. These should be expected to be similar in both progenies, but this is not the case. In the former, a 1 : 3 backcross ratio confirms the 9 : 7 ratio in the F_2. In the latter, however, the purples are in excess of the greens, an observation which appears to be contrary to the expected 1 : 3 ratio.

The results of fruits A 3 and A 4 which were the product of the pollination of F_1 with the dominant Black Pekin, are as would have been expected, all purple plants.

Finally, the results for the eight progenies are given together, and are therefore of no value from the standpoint of the analysis of color.

Two other crosses, Giant Round Purple × White Chinese and Long White × Black Pekin, are also reported but the populations in all of the F_2 or backcross progenies are too small to be of value in determining ratios.

Munson (6) in 1892 reported further on the above crosses. This same writer, later in 1905 (7) commenting on eggplant crossing further reaffirms the dominance of purple color of fruit over white; but makes no other contribution to the knowledge of inheritance in this plant. It must be remembered that Mendel's epoch-making studies on inheritance had already been discovered at the time of this later publication.

Owen (9), in 1912 reported on the F_2 generation data of cross Long White × Dwarf Purple and in a population of 90 plants found 59 with purple stems to 31 with green stems.

Here again a 9 : 7 ratio shows a behavior for plant color similar to that reported by Bailey and Munson. It is of interest to note that all the green-stemmed plants bore either greenish white or ivory fruits, colors which are recessive to purple or violet. This indicates a possible linkage of recessive factors for plant and fruit color or a single gene that affects both plant and fruit color. The purple-stemmed plants bore purple or violet fruit.

The same writer (10) again in 1917 gave some data on F_2 generations of crosses made in previous years but the numbers are very

small. He, however, points again to the dominance of purple color of fruit over green.

Halsted (**5**) found a 3:1 ratio of green to white color of flesh and a similar ratio of purple to colorless skin (Green purple × White colorless). In the cross Long White × Dwarf Purple he obtained a 9:3:3:1 ratio of purple, green, pink and white skin. For this proportion a two-factor hypothesis should be assumed, the two dominant factors producing purple, the absence of the first producing green color, that of the second pink color, and the absence of both dominant factors resulting in the production of white fruits. It must be remembered that in the same cross, Owen (**9**) had obtained results for plant color which agree with the 9:7 ratio.

Bayla (**1**) gave results of a cross between a Purplish Native Elongated × New York Improved. From his work would seem that direct and reciprocal crosses do not give similar F_1 progenies. His study of the F_2 generation is very incomplete; he speaks about the F_2 hybrid, but no attempt is made at the study of the inheritance of color or any other character. Segregation is not studied in this generation.

In general, the data secured by the early investigators were insufficient for a complete analysis of the inheritance of color in the eggplant. The best data seem to be those given by Bailey and Munson (**3**) who were the only ones to make use of the backcross method. Summarizing these investigations it may be said that data have been offered suggesting a 9:7 ratio for plant color and 9:7, 9:3:3:1 and 3:1 ratio for fruit color and a 3:1 ratio for color of flesh.

It is the purpose of this paper to present the results of our studies on the inheritance of color of plant, fruit, and corolla, and the red-striped character of the anthers. In this connection purple color of plant has been studied as against green color, purple or violet corolla against white corolla, striped against non-striped anthers, purple fruit color in contrast to green or white and green color against white.

MATERIALS USED

The most important characters of the native eggplants used in these studies are given in table I. (See half-tone plates.)

It should be noted that the anther sacs burst as follows: in the varieties Fajardo, White Pompadour and Long Purple K, just before expansion of the corolla; in Camuy, Black Beauty, University and Green, during or after the corolla opens.

TABLE I. SHOWING THE SALIENT CHARACTERS OF THE EGGPLANT VARIETIES USED IN THIS PAPER

Variety	Plant Color		Fruit color	Corolla color	Anthers	
	Seedling stage	Adult plant			Striped	Non-sptriped
Fajardo...	Green	Light Purple	Green purple striped	Violaceous		X
Camuy........	Dark purple	Dark purple	Red to violaceous	Deep violaceous	X	
White Pompadour.........	Green or light purple	Light Purple	White purple striped	Violaceous		X
University....	Purple	Purple	Pink	Violaceous	X	
Green.....................	Green	Green	Green	White		X
Black Beauty.	Light Purple	Light Purple	Purple	Violaceous	X	

The first planting of some of the varieties was made in the fall of 1926 and some crosses made the succeeding winter of 1926–27. Only a few of the crosses were made that season because not all of the varieties had been secured. Gradually additions were made to the collection and new crosses made. The first generation of the 1926–27 crosses was grown in the summer of 1927, and F_2 and back-cross generations planted in the fall of that same year, and data gathered early in 1928. When possible two generations were grown in the same year.

Emasculations were made as short a time before the bursting of the anthers as possible, which was the day previous to the opening of the corolla in all varieties except Fajardo, Long Purple K and White Pompadour where it was necessary to emasculate two days in advance of corolla opening. Pollinations were made as soon as the corollas were expanded. In the removal of the anthers and in the pollinating operations, the flowers were disturbed as little as possible to avoid unnecessary injury and consequent blasting of the fruits. They were properly bagged and tagged. The bags were removed after the young fruit had set, usually five or six days after pollination. All selfing was made by covering up the blossoms with glassine bags before expansion of the corolla.

The fruits were gathered when there was evidence of the yellow coloration on them and seed was cleaned immediately, dried in the shade and stored in mason jars in which a beaker of calcium chloride had been placed. There is little difficulty with the viability of the seed under such storage conditions.

The seed were sown in ordinary greenhouse flats from which 2–to 3–week–old plants were transplanted to other plots, allowing 12 to 16 square inches of soil per plant. The plots were carefully labeled to avoid any possible errors. With a reasonable amount of care the loss from transplanting was negligible.

It was soon found that plant color could be determined at the time when the seedlings were transplanted. The seedlings of the White Pompadour and the Fajardo do not develop any purple color before the second week and those of the Green variety are pure green from the beginning. In seedlings of the Black Beauty, color was evident after the first week and in those of Camuy and University it appears very early. Thus, in crosses in which any of the first three was involved with any of the remaining varieties, the seedlings were classed in two groups as colored and colorless (green). (See color plate III).

The sorting of seedlings presents no difficulty when the cross is between Green and any variety with purple seedlings, but when Green is crossed with either Fajardo or White Pompadour some difficulty is experienced making it necessary, with certain individuals, to make the final classification when the plants are transferred to the field. In the large seedlings (5 to 6 pairs of leaves) the purple color begins to appear in spots on the stem; but usually first on the main veins at the base of the leaf blade or on the petiole. In crosses between Fajardo or White Pompadour and any of the colored varieties the sorting out must be done early before any coloration shows in the recessive seedlings; if one waits too long they will be indistinguishable from the dominant ones.

The varieties given in the order of intensity of color of seedlings is as follows: Camuy, University, Black Beauty, White Pompadour and Fajardo.

If counts for plant color made in the seedbed on any given cross were confirmed by later field observations, duplicate crosses were carried only through the seedbed and there discarded.

Plantings in the field were made in rows three and one-half feet apart. Each row was numbered consecutively and the serial number kept season after season, starting with the second generation in 1927–28. A record was kept of each individual plant throughout the entire investigation making reference to row number and plant number. In this way it was very easy to trace back the history of any one of the many thousand seedlings grown in later generations.

Our data secured from F_2's and backcrosses are given below.

PLANT COLOR

Under plant color will be presented the study of the inheritance of the purple color in the different varieties. Since it was desirable to know whether the variations in color in the several varieties were really different, most of the varieties were tested with Green where the color remains constant throughout the entire life of the plant and with Fajardo where the green color changes to light purple during the seedling stage.

Table II shows the data on plant color in the various crosses. Observed numbers have been calculated on the basis of a 3 : 1 ratio and are also given in table II. Likewise, deviations from the observed numbers and probable errors, are also given.

In every case purple color was dominant over the green of either Fajardo or Green; the F_1 plants in all the crosses were purple.

The different shades of purple found in Camuy, Black Beauty and University reacted similarly toward Green. A second green found in Fajardo when crossed with University purple gave results similar to those secured in crosses of Green with purple varieties. It should be remembered that the Fajardo green is in reality a purple which does not appear until two or three weeks after the seedlings emerge.

TABLE II. SHOWING PLANT COLOR DATA ON F_2 AND BACKCROSS OF THE VARIOS CROSSES.

Progeny		Observed		Calculated	Deviation	P. E.	D/P. E.
		n	ratio				
1—Ca x Gr.	Purple	885	2.94:1	889.50	4.5	±10.06	0.447
	Green	301		296 50			
2—Gr x Ca.	Purple	1592	3.19:1	1580 25	11.75	±13.4	0.87
	Green	515		526.75			
3—(Ca x Gr) x Gr.	Purple	149	1.09:1	143	6.0	±5 70	1.05
	Green	137		143			
4—Gr x BB.	Purple	2404	2 80:1	2446 50	42.5	±16.65	2.55
	Green	858		815 50			
5—BB x Gr.	Purple	442	2.73:1	453	11.0	±7.17	1.39
	Green	162		151			
6—(Gr x BB) x Gr.	Purple	121	1.15:1	113	8.0	±5.07	1.58
	Green	105		113			
7—(BB x Gr) x Gr.	Purple	169	1 17:1	157	12.0	±5.98	2.0
	Green	145		157			
8—Univ. x F	Purple	106	3.42:1	102 75	3.25	±3.42	0.95
	Green-striped	31		34 25			
9—F x Univ	Purple	213	3.28:1	208.50	4 50	±4.87	0.92
	Green-striped	65		69.50			
10—Univ. x Gr.	Purple	152	4:1	142.50	9.50	±4.03	2.36
	Green	38		47.50			
11—Gr x Univ.	Purple	191	2.85:1	193.50	2.50	±4.69	0.53
	Green	67		64.50			
12—(Univ. x Gr) x Gr.	Purple	50	0 93:1	52.00	2 0	±3.44	0.58
	Green	54		52.00			

It can be generally said that observations agree fairly well with expectations on the basis of a 3:1 ratio of purple to green color of the variety Green (progenies 1–7 and 10–12). In every case the deviation is less than three times the probable error and, therefore, should be considered insignificant and can be attributed to random sampling. The green of Fajardo reacted in a similar way toward purple (progenies 8 and 9).

No progenies of backcrosses of Univ. × F have been produced. The first attempt was frustrated by damping-off of the seedlings of the only two progenies that germinated; a second attempt last summer was unsuccessful because of the very few seedlings that germinated. Consequently the evidence offered for a 3:1 ratio of purple to this green is based only on F_2 progenies.

It is clear that the different shades of purple found in the varieties Camuy, Black Beauty and University react similarly toward Green. A second green (Fajardo) when crossed with University, gave results similar to those secured in crosses of Green with purple varieties.

The assumption of one unit factor pair *Pr pr* for plant color will explain satisfactorily the results obtained.

FRUIT, ANTHER AND COROLLA COLOR

The study of inheritance of fruit color has involved the behavior of purple, red, pink, green purple striped and white purple striped. In corolla color we have been concerned with violet, purple and white and in stamen color we have dealt with red striped and non-striped anthers. In the preceding pages the data on plant color has been presented for four crosses. Our observations in those crosses have shown that green color of fruit is always associated with green plant color and purple, red and pink with purple color of plants. In the case of color of corolla it was found that white corolla was always associated with green color of plant in all the crosses. The non-striped character of the anthers always indicated recessiveness of fruit or plant color. Thus, in cases of crosses with Fajardo where corolla is colored and fruit is green, the recessive plants (green) always bore green fruit and non-striped anthers. In crosses with Green as a parent the green plants always bore green fruit, white corolla and non-striped anthers.

Therefore, the data and conclusions used in the analysis of plant color, will be the same for these characters.

FRUIT COLOR

In the crosses *Ca* × *Gr* (red × green), BB × Gr (purple × green) and Univ. × Gr (pink × green) a 3:1 ratio was found for plant color and since green fruit color was associated with green plant color the same ratio must apply to fruit color in these crosses.

In the cross Univ. × F (pink × green purple striped) a similar relation was found; all the plants sorted in seedbed as green bore green purple striped fruit.

Crosses between Black Beauty and Fajardo were made twice, but the F_2 and backcross data were not sufficient to arrive at proper conclusions as to ratio of inheritance. They proved, however, absolute dominance of purple over green fruit color.

In order to determine the relation of purple and green purple striped to white purple striped, Black Beauty (purple) and Fajardo (green purple striped) were crossed with White Pompadour (white purple-striped). Part of the progenies of the first cross was lost but dominance of purple was proved.

The results of the last cross appear in the following table.

TABLE III. FRUIT COLOR.

Progeny		Observed n	Observed ratio	Calculated	Deviation	P. E.	D/P. E.
13—Wh. P x F	Green	116	4 1	108.75	7.25	±3.52	2.05
	White	29		36 25			
14—F. x Wh. P.	Green	120	3.44:1	126.75	6 75	±3 79	1 78
	White	49		42 25			
15—(F. x Wh. P.) x Wh. P.	Green	127	1 1.1	134	7 00	±5 52	1 27
	White	141		134			

The evidence of F_2 data in the above table supports the assumption of a 3:1 ratio of green purple striped to white purple striped fruit. The backcross data furnish additional confirmation of expected results.

Summarizing the observations on fruit color it may be concluded that the red, pink and purples are dominant over green, green purple striped and white purple striped, but green purple striped was dominant over white purple striped. A 3:1 ratio was obtained with purple, red and pink in relation to green; a similar ratio between white purple striped and green purple striped. Therefore, one unit character produces color of fruit. It may be represented by *Cc*.

It should be remembered in closing, that certain unexplained observations were made in some of the F_2 progenies. In the F_2 of Univ. × F, five plants with white purple striped fruits were found

and classed with green for the purpose of the relation of pink to green. When perpetuated they have been found to breed true; i. e. the fruit is always white purple striped. In every other respect they are like Fajardo (green fruited) plants. Both University and Fajardo are true breeding varieties and therefore the appearance of these white purple striped fruit-bearing plants has been a matter of much interest to us during the whole time this work has been in progress. Things appeared still more complicated when two plants with these white purple striped fruits were discovered in the cross F $\times$ Univ.

This phenomenon is, to our mind, of much interest since it may throw some light on the true nature of the variety Fajardo which, as reported to us, arose in a graft of a white eggplant on *Solanum torvum*. The only difference between the new puzzling individuals and Fajardo individuals lies in the color of fruit; color of plant, corolla, and anthers, and shape of fruit are like in the Fajardo. In no case was an individual with white fruits obtained in any of many progenies of selfed Fajardo fruits.

The writer would make further studies with these interesting whites if it should be possible in the future.

It should be noted, in passing, that the observations of other writers in this respect are of interest. Owen (**8**) in 1912, for instance, in the F_2 of a cross where white and purple color were involved found greenish white fruited plants, and Halsted (**4**) in the same cross obtained greens again in a proportion of 3 : 1 toward the whites and even pink-colored fruits. The pink color in Halsted's may be explained as a dilution of the purple in the Dwarf Purple parent.

COLOR OF COROLLA

In these studies purple or violet (colored) corolla has been contrasted to white (non-colored).

In the direct and reciprocal crosses Ca $\times$ Gr, BB $\times$ Gr and Univ. $\times$ Gr it was found in the F_2 and backcross progenies that white corolla was always associated with green color of plant and fruit. Consequently the same general conclusions in the genetical analysis can be drawn for color of corolla as for plant and fruit color, namely that a 3 : 1 relation exists between color and no color and that colored corolla is due to one unit factor which may be represented by C_1 and white color by its absence and represented by C_1.

STRIPING AND NON-STRIPING OF ANTHERS

Striped anthers occur in the parents Black Beauty, University, Camuy and non-striped anthers in White Pompadour, Fajardo and Green.

In the crosses Ca × Gr, BB × Gr, Univ. × Gr. and Univ. × F, the absence of the stripes on the anthers was evident in the plants with the green fruits and in the first three of these crosses it was associated not only with green color of fruits but also with green plants and white corollas. In the cross Wh. P. × F where both parents had non-striped anthers, the F_1, F_2 and backcross progenies had all non-striped anthers. Hence, the same conclusions will hold for striping of anthers as for plant, fruit and corolla color. A unit factor will be assumed and represented as *St* with its recessive allelomorph *st*.

SUMMARY AND CONCLUSIONS

(1) Inheritance studies on the color in the eggplants have been made by various investigators but the first one to attempt an analysis was Halsted (**5**) who reported a 3:1 ratio of green to white color of flesh and a similar ratio of purple to colorless skin; also a 9:3:3:1 ratio of purple, green, pink, and white fruit. Several workers have pointed out the dominance of purple color over white in fruits. Bayla (**1**) apparently regarded F_1 generations of reciprocal crosses as dissimilar.

(2) The methods employed in the various crosses are given.

(3) Seedlings in some of the crosses could be classified according to their color during the very early stages. Plants of the Green variety remain green throughout the entire life cycle, those of Fajardo and White Pompadour are green during the first two or three weeks only and then turn light purple; while those of Camuy, Black Beauty and University are purple from the very beginning.

(4) Intense purple color of Camuy is inherited in a 3:1 ratio to Green. The same ratio exists between the green of Green and the purple of University and Black Beauty. The University purple is inherited in the same ratio in respect to Fajardo green purple striped. For all these a unit factor *Pr pr* is assumed.

(5) Green color of fruit in the crosses studied is always associated with green plant color; and purple, red and pink with purple color of plant. White corolla is always associated with green color of plant; striped anthers with a recessive factor for fruit or plant color.

(6) Red, purple and pink color of fruit is dominant over green and inherited in a 3:1 ratio. Likewise green purple striped is domi-

nant over white purple striped and is inherited in a 3 : 1 ratio. Purple was proved to be also dominant over white purple striped. Green purple striped acts as a recessive in respect to pink or purple, but as a dominant in respect to white purple striped.

(7) Violet or purple corolla is dominant over white corolla. They stand in a 3 : 1 ratio in the F_2 generation.

(8) Striping of anthers is dominant over non-striping and is inherited in a 3 : 1 ratio.

(9) A unit factor appears to exist for each of the characters; color of plant, color of fruit, color of corolla and striping of anthers. The following allelomorphic pairs of factors are assumed: plant color *Pr pr*, fruit color *Cc*, corolla color C_1c_1, and striped character of anthers *St st*. A single factor might be assumed as affecting all the characters here involved.

(10) There may be complete linkage between these characters: White corolla and non-striped anthers always stand for green fruit, and green plant (all recessive characters). On the other hand striped anthers always go with bright-colored fruit and with purple plants.

(11) The composition of a green plant with white corolla, green fruit and non-striped anthers may be represented as prpr cc C_1 c_1 stst, or as prpr, cc, etc.

ACKNOWLEDGMENTS

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Ithaca, N. Y.

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Explanation of Plates

Plate III. Plant Color. Parents Camuy (1), and Green (2). Fig. 3 is the F_1 of the cross Camuy $\times$ Green. Figs. 4–7, F_2 generation seedlings, 3:1 ratio of purples to green.

Plate IV. Corolla and anther characters, Fig. 1, corolla of Camuy, anthers striped; fig. 2, Fajardo, non-striped anthers; fig. 3, white Pampadour, non-striped anthers; fig. 4, University, striped anthers; and fig. 5, white corolla of Green, anthers non-striped.

Plate V.—Black beauty eggplant.

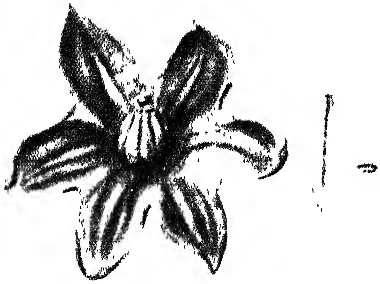
Plate VI.—Fajardo eggplant.

Plate VII.—University eggplant.

Plate VIII.—Left: Green eggplant,
Right: White pompadour eggplant.

PLATE III.

PLATE IV.



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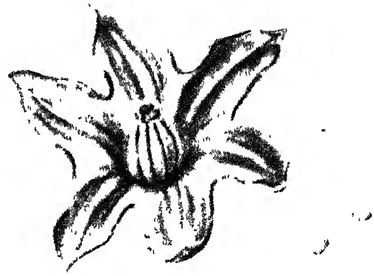

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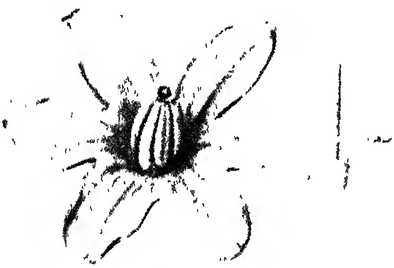

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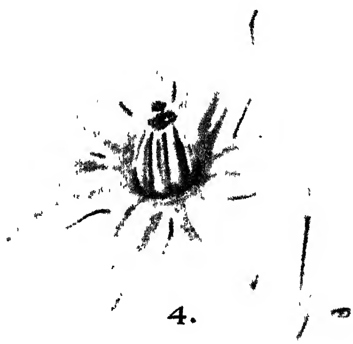


4.

F.W. Horne

5.

PLATE V.

PLATE VI.

PLATE VII.

PLATE VIII.

A NEW SPHAERODACTYL FROM PORTO RICO

CHAPMAN GRANT, Major, United States Army

Sphaerodactylus gaigeae sp. nov.

Type No. 3358, male, Chapman Grant Collection, 7 Sept., 1931, mountains near Yabucoa, Porto Rico; collector, Chapman Grant.

Diagnosis: A *Sphaerodactylus* of medium size, 45 mm., very dark above, almost black; usually dark beneath. Throat dark with white spots, but this unique character fades in alcohol; habitus slim; scapular pattern wanting or reduced to light dots; head pattern in shape of "chevrons". No sexual dichromatism. Snout and throat strongly keeled.

Habitat: Mountains between Maunabo and Yabucoa, Porto Rico. Found under vegetable trash in moist situations.

Proportions: Slender; medium size, 45 mm. adult average.

Squamation: Upper side; scales across snout just in front of eyes, 12. This line to snout, 5. Scales all keeled including those bordering rostral. Lower side; Larger scales bordering mental, followed by smaller scales which increase in size at neck. All strongly keeled including chest. Belly scales smooth. Male escutcheon large.

Color and markings: No sexual dichromatism. Above; very dark brown, almost black. Head pattern a black "chevron", apex pointed forward at occiput outlined by a narrow light margin. Head pattern is unique among Porto Rican and adjacent island forms. Scapular pattern wanting or reduced to two light dots. Occasionally a sacral pattern of a pair of light longitudinal lines outlining three or four black scallops beginning at sacrum and extending onto tail. Below; chin black with light dots. This is a unique marking, but fades in alcohol. Belly marbled with dark, occasionally all gray. Also fades in alcohol. Underside of tail usually deep orange, occasionally brown. The orange fades in alcohol.

Remarks: Specimens taken, 22. This species is found associated with S. *grandisquamis*. When capturing these specimens I thought I was taking immature *S. klauberi*. This is the only "black" smooth bellied species known to occur on Porto Rico or the adjacent islands. It is much the blackest form, *S. klauberi* being a dark walnut. Named in honor of Helen T. Gaige.

CHART FOR DETERMINING THE SPHAERODACTYLS OF THE PORTO RICO REGION

CHAPMAN GRANT, Major, United States Army

It is hoped that the reader has seen the paper by the same author describing five new *Sphaerodactyls* and reestablishing another in the July number of this Journal as this chart is for the ready determination of these and the new species described in this number of the Journal. Altogether there are eight species now known from this region.

I find that a key has an objectionable feature because a decision must frequently be made on a matter of opinion or definition. A reader unfamiliar with a group may be led astray by a wrong choice while using a key. In the present chart any specimen may be referred to any of the thirteen columns. There is no necessity for starting over as is necessary with a key, because if one column leads to an impasse with a certain specimen, the student may ignore that character and run down one of the other columns.

In making an identification it is advisable first to determine the sex of the specimen. It will be noted that three of the eight species have sexual dichromatism. Sex determination immediately narrows the field.

Sex determination is easy in this genus. Examine the belly scales with a hand lenz. The male has a chevron shaped patch of noticeably flat or slightly concaved and usually lighter colored scales anterior to the vent. The branches of the chevron extend onto the hind legs. The scales of this part of the female are not differentiated. See Plate XX. July number of this Journal.

Use of the Chart. Explanation of Terms.

In Column 6, the "cross" on the head of *S. monensis* is more or less a matter of opinion. I will gladly adopt a more comprehensive term. The advantage of the term "cross" is that there are various types of crosses. There are also various designs on the head of *S. monensis.*

"The target" is an oval occipital spot encircled by an oval ring, usually of the same color.

Columns 7 and 8. The species of this group have a dark line or the vestiges of one, beginning at the eye and extending backwards for various distances according to the species. This line is bordered

above by a lighter line, also extending variously according to the species.

Column 9. The "chin" bears a pattern that is quite specific in certain forms. By "chin" is meant the area from the mental to a line joining the bulbs of the lower jaw. Some might call it the "throat".

Column 10. The "scapular pattern" is a feature of this genus. It is best shown in *S. grandisquamis.* In this species it usually consists of a black blotch across the shoulders, outlined by white and bearing two white dots. The resemblance to a mask is striking. "Spectacle" is suggested by Dr. Barbour for the scapular pattern when it tends to change from a mask to two little tangent targets.

Column 11. The "sacral pattern" is second only to the scapular pattern in this genus. Usually it is most conspicuous at the region of the sacrum, but is frequently repeated several times along the tail. Generally it is formed by a continuation or reappearance of the ocular white line and the outermost dorsal dark line or line of dots which is intensified at this point. The form and degree of this pattern is specific.

Columns 9, 12 and 13. Keels: It is very difficult to determine whether or not certain scales are keeled in these species. It is necessary to let the specimen become slightly dry and to scan it with a hand lenz in a mild light that comes from the side. A bright light or a direct light, moisture or too high magnification make the keels almost invisible.

Notes to Sphaerodactyl Chart.

1. Fades in alcohol.

2. The Culebra form only is covered in this chart. The form from Vieques is covered by these notes where it differs from the Culebra form and is referred to by the letter "V". The Culebra form is referred to by the letter "C".

3. Red head. The C has a plain red head above in 22 per cent of the males, with no intermediate forms with the speckle head males. The V has a larger per cent of red head males and the red continues underneath the head as red or orange. Some have a dark occipital spot on the red head and some have spotted or marbled chins, whereas C invariably has a white chin and no occipital spot.

4. Brown. The V is much darker brown than C.

5. V males, not the red heads, have regular "target" or mottled head.

6. See Note 3.

7. In V this line is much darker, nearly black.

8. V males have the dark eye line a light brown instead of "black".

9. White in V.

10. In V, gray or black and white speckled or striped.

11. In V, orange or white or gray or mottled. The orange fades in alcohol.

12. In V, reduced or wanting.

13. In V, usual.

14. In V, same pattern, but repeated several times onto tail.

THE HERPETOLOGY OF VIEQUES ISLAND

CHAPMAN GRANT, Major, United States Army

Dr. Leonard Stejneger, 1904, in "The Herpetology of Porto Rico" lists eleven reptiles and amphibians from Vieques, as follows:

Species	Latest Record	
1. *Leptodactylus albilabris*	Stejneger	1900
2. *Eleutherodactylus antillensis*	Stejneger	1900
3. *Sphaerodactylus grandisquamis*	Stejneger	1900
4. *Anolis cuvieri*	Reinhardt & Luetken	1862
5. *Anolis cristatellus*	Stejneger	1900
6. *Anolis stratulus*	C. W. Richmond	1900
7. *Anolis pulchellus* "?"	Reinhardt & Luetken	1862
8. *Ameiva exsul*	Reinhardt & Luetken	1863
9. *Mabuya sloanii*	Riise	1863
10. *Typhlops jamaicensis* "?"	Reinhardt & Luetken "Virgin Islands"	1863
11. *Alsophis antillensis*	Boulenger	1894

He lists *Anolis pulchellus* and *Typhlops* jamaicensis with a "?". The latter is recorded from the "Virgin Islands". It is clear that he expected both species to be on Vieques, but had no proof in regard to *Typhlops*.

Karl P. Schmidt, 1928, in the Scientific Survey of Porto Rico and the Virgin Islands lists 10 of the same reptiles and amphibians from Vieques. He apparently took only *A. cristatellus, pullchellus* and *stratulus,* counting on the authority of Stejneger for the remainder. He leaves out *Typhlops* which Stejneger included only on probability.

The writer made a trip to the Island in 1931, where, with the assistance and hospitality of Mr. S. C. McCall, 6 species were added to the fauna and 1 removed, bringing, the total to 15.

I found the two *Salentia* very numerous and noisy.

The first new record, *Hemidactylus mabouia,* was found around old stone buildings at night. It is discussed elsewhere in this issue. *Sphaerodactylus townsendi* and *S. roosevelti* occur on the extreme eastern dry tip of the Island. Elsewhere *Sphaerodactylus danforthi* or a closely allied form occurs under trash or palm leaves. This is a two-color-phase-male form. On Culebra there were no intermediates between the speckled head and red-head males, but on Vieques all integrades were found. The form from Vieques shows constant

minor differences from *Sphaerodactylus danforthi,* which I believe to be of specific or sub-specific value. They are discussed in another paper. Searching on the extreme dry eastern tip of the Island, in the almost impenetrable brush, I turned over the remains of a deserted termite nest which had fallen to the ground. I saw a large, coarsely scaled *Sphaerodactylus* and grabbed. To my delight, I felt the wriggle in my hand, but upon examination, I found only a part of the tail. A diligent search failed to recover the important part of the specimen. The glimpse I had made me think it was *S. roosevelti.* I turned over a rock nearby and found the hatched shells of large *Sphaerodactylus* eggs and one partly incubated egg. A month later, Oct. 28, 1931, the egg hatched into what might well be a female *S. roosevelti.* I made color notes as follows: Bright yellow, brightest at tail. A light yellow stripe starts between eyes and extends to tip of tail, bordered on head by slightly darker edges. Dark greenish yellow stripe, width of eye, extends nearly to end of tail, but at scapular region this line is jet black with a tiny white dot in the center. At sacral region, this line is little darker. Behind eye a light yellow line which is interrupted at ear and recommences behind ear runs well onto the tail. A narrow dark line below the latter. Flanks bright yellow. Tiny tip of tail white. A beautiful creature. 32 mm. long when hatched. Egg 9×7 mm. The following day the colors began to fade and the day thereafter the skin loosened up preparatory to shedding. The adult *S. roosevelti* does not have any yellow, but it is quite possible that the young may have it. The classification of the above specimen is tentative until young of *S. roosevelti* are taken at the southwest corner of Porto Rico, whence I described the species in this Journal, Vol. XV No. 3, page 203 and plate.

Anolis cristatellus is numerous. The fan has a broader orange band than the Porto Rico form but does not approach the color or width of the Culebra form.[1] I found the high tail fin in about the same proportion as on Porto Rico. I searched for *Anolis stratulus* but failed to find any. *Anolis pulchellus* was not very abundant. I looked for a variant on the dry eastern end of the Island but neither was to be found. I did not find a native who had ever seen *Anolis cuvieri.*

Ameiva exsul fairly swarms on outlying keys. Schmidt thought it extinct on the main Island where the mongoose abounds, but I saw a few *Ameivas* on the eastern extremity. I believe it is too dry there for the mongoose.

Mabuya was not seen or known to the natives.

I have one specimen of *Typhlops* sp. collected by Mr. S. C. Mc Call.

Alsophis antillensis is probably nearly extinct except on outlying keys or possibly the eastern tip of the Island. Some natives report having seen a few snakes within the past several years.

The natives speak of the "culebrón", *Epicrates* as occurring on the off shore keys.

I saw a pet *Pseudemys* in a cistern. The natives claim they are numerous in the lagoons and are sold on the streets for fifteen cents apiece.

An old citizen of repute says that after several of the hurricanes, large agglomerations of broken branches and trees have floated over from Porto Rico and that *Pseudemys* has been found in such situations. Such a phenomenon would require an unusual wind of sufficient duration and intensity to overcome the current running between the two islands. Personally, I believe that *Pseudemys* and *Epicrates* are the only forms which might survive such an experience.

The species that I strike from the list is Stejneger's *S. grandisquamis* or *S. macrolepis* which Schmidt later confused with *S. grandisquamis*. See page 43 of this issue for discussion.

The herpetological list of Vieques I believe comprises the following:

Species	Latest Record	
1. *Leptodactylus albilabris*	Grant	1931
2. *Eleutherodactylus antillensis*	Grant	1931
3. *Hemidactylus mabouia* "*"	Grant	1931
4. *Sphaerodactylus townsendi* "*"	Grant	1931
5. *Sphaerodactylus danforthi* "*"	Grant	1931
6. *Sphaerodactylus roosevelti* "*"	Grant	1931
7. *Anolis cristatellus*	Grant	1931
8. *Anolis stratulus* "?"	Schmidt	1928
9. *Anolis pulchellus*	Grant	1931
10. *Anolis cuvieri* "?"	Reinhardt & Luetken	1862
11. *Ameiva exsul*	Grant	1931
12. *Mabuya sloanii* "?"	Riise	1863
13. *Typhlops, sp.* "*"	Grant	1931
14. *Alsophis antillensis* "?"	Boulenger	1894
15. *Pseudemys stejnegeri* "*"	Grant	1931

NOTE: 1. See p. 220 Vol. XV No. 3 of this Journal.
The "?" denotes species not collected by the writer.
The "*" denotes species added by the writer.

BUFO LEMUR, A RARE PORTO RICAN TOAD

CHAPMAN GRANT, Major, United States Army

Bufo lemur was known to the natives of Porto Rico as "sapo concho" because of its bony or shell-like head. At the time of Dr. Stejneger's visit, the name had been transferred to *Leptodactylus albilabris*. At present *Bufo marinus* bears the name for which it does not qualify. *Bufo lemur* seems to have always been scarce, or its hiding places are not yet understood.

Cope named the form *Peltaphryne lemur* in 1868. Peters called it *Peltaphryne gutturosus* in 1876 and Gundlach, *Bufo gutturosus* in 1881. Stejneger straightened things out in 1902 with *Bufo lemur*.

The only records that I can find of its capture are:

Dr. Stahl secured six specimens in forty years of collecting in the 18—'s. Stejneger captured five specimens near Arecibo in 1900. Schmidt took five specimens at Coamo Springs in 1919, thereby greatly enlarging the known range of the species. It had been known only from the north side of the Island. Dr. J. García Díaz secured one at Arecibo in 1925. Mrs. D. J. Haydon, of the University of Porto Rico secured two from Barceloneta in 1928. Danforth collected eight at Coamo Springs in 1929. I captured the present specimen a mile north of Coamo Springs in 1931. A total of only 28 known specimens of this species taken in sixty-three years.

Noticeable about this toad is its limber back bone. It can turn about so that in handling it, it feels more like a warty salamander than a toad. Its mouth is not terminal as in ordinary toads but underneath like a shark's. When captured, it was sooty black all over. Soon it turned to a black and white marbled symmetrical pattern, too complicated to try to describe. The hour glass pattern on the back mentioned by Stejneger is present. The eyes of this specimen are decidedly coppery instead of brassy as in the specimen that Stejneger describes.

Dropped into a tub of water it swims well on and below the surface. Kept in a bottle it ate two katydids, tiger beetle, *Anolis cristatellus* 4″ long and cockroaches.

This toad is closely allied to *B. empusus* (Cope), of Cuba and *B. gutturosus* Latreille of Hispaniola, both of which are relatively common. *Bufo turpis* Barbour of Virgin Gorda was known only from the type specimen until Dr. Stuart Danforth of the University of Porto Rico at Mayagüez took eight specimens last year. He found them under the bark of dead mangrove trees.

EXPLANATION OF PLATE IX

Bufo lemur front view and side view. This is probably the only picture ever taken of this species alive. Photos by Capt. F. V. Edgerton, U.S.A.

PLATE IX.

SPHAERODACTYLUS GRANDISQUAMIS, A VALID SPECIES

CHAPMAN GRANT, Major, United States Army

Stejneger [1] described *Sphaerodactylus grandisquamis* in 1902 from a series of 47 specimens taken at Luquillo and near Ponce. He added 9 other specimens from Vieques under this name, altho noting a marked difference in coloration and pattern.

The selection of the name *grandisquamis* was not a happy one as it calls attention to a trivial and uncertain factor. Unfortunately Dr. Stejneger attributed the sexual dichromatism and markings which are so distinct in this species to individual variation. He did not have a sufficient series to make it apparent to him that this species is larger than *macrolepis*, nor that *grandisquamis* is the only species with a distinct white tail tip and a usually perfect scapular "mask".

In 1914 Barbour [2] says: "This species, [*grandisquamis*] which had hitherto been confounded with *Sphaerodactylus macrolepis* Gunther, the type locality of which was St. Thomas, has been shown by Stejneger to be perfectly distinct, yet to have close affinity with Gunther's species. Stejneger's species may easily be separated by its much larger dorsal scales. In its distribution it is confined to Porto Rico and Vieques".

In 1915 ? Fowler [3] accepts the species without question: "Three from Arecibo Road, Porto Rico, about the 70 km. post; these are similar to Dr. Stejneger's figure,[4] [this figure is of a female], except that the black scapular blotch has in each example two small pure white spots. Two specimens have the dark spots as more or less broken longitudinal bands, [probably females] though in the remaining example a more speckled appearance is seen and the spots are smaller." Undoubtedly this last is a male.

Again a series too small to make evident the interesting sexual dichromatism and markings of this form.

In 1917 Barbour [5] says: "*Sphaerodactylus macrolepis* Gunther. In the collection there are specimens from St. Thomas, Tortola, Virgin Gorda and Anegada. These have been compared with a large series in the M. C. Z. from St. Croix. All belong to the same species; the Anegada specimens are much paler, more ashy, than any of the others and the variation observable in this large number of individuals shows that *Sphaerodactylus grandisquamis* Stejneger,

from Porto Rico, distinguished by the larger size of the dorsal scales is really far from conspicuously distinct. The species may perhaps stand, however, since there is no doubt but that the average number of scales upon the dorsal area is slightly fewer.''

We must begin to note that there are other things than scale counts which when constant, constitute a species.

In 1920, Schmidt [6] lumps the two species together. I have not seen his paper.

In 1921 Barbour [7] states: ''I cannot, with this large material before me, find any stable character separating *macrolepis* from *grandisquamis*. Certainly in specimens of equal size the dorsal scales differ but very little in size. In the topotype of *macrolepis*, figured, they are actually larger than in the specimen of *grandisquamis*. . .''

Barbour's figures are of females of *S. macrolepis* fig. 2 and *S. grandisquamis* fig. 3. In his description of *macrolepis* he uses a Porto Rico specimen, i.e. *grandisquamis*. If we could only get away from scale counting and not let the trees obscure the forest.

In 1928, Schmidt [8] lumps *macrolepis, grandisquamis* and *monensis*. He shows cuts of a male and a female as ''common types of pattern''. He proves that by scale count the three species are one. No attention has been paid to color, size, pattern, sexual differences, proportions or habits, which differ and are constant in each of the three species.

In 1930, Barbour [9] does not list *monensis* or *grandisquamis*, allowing *macrolepis* to answer for the three.

In the July number of this Journal, I reestablished the validity of *monensis*. I had not seen specimens from St. Croix, so considered them identical with the Porto Rican form. This belief was engendered by the quotations at the beginning of this article. Upon collecting a small series from St. Croix, I immediately realized that the Porto Rico form was distinct, and therefore *grandisquamis* was valid. The close similarity between the forms from St. Croix, Culebra and Vieques would make my *danforthi* from Culebra and Vieques of only sub-specific value, if it were not for the fact that I found no red-head males on St. Croix and find no mention of this phase in the literature. A larger series from St. Croix may show the forms from St. Croix, Culebra and Vieques to be sub-specific inter se. My ''Chart for Determining the Sphaerodactyls of the Porto Rican Region'' in this issue still further brings out the differences between the species.

My opinions are based on fifteen months of constant work in the field where I have observed hundreds of specimens. I have hatched

out many eggs and observed the young. My study collection at this time contains 228 *grandisquamis* from Porto Rico and 157 *danforthi* from Culebra; 63 *danforthi* from Vieques and 11 *macrolepis* from St. Croix.

It is my conviction that the specific differences of the Sphaerodactyls of the Porto Rico region should be based on the characters shown in my "Chart" as well as on scale count.

A resume of the outstanding differences between the four species is not amiss here as *macrolepis* is not included in my "Chart". There are other constant differences between the St. Croix, Vieques and Culebra forms which are omitted here.

	White tail tip	Av. adult size	Sex dichromatism	Color above	Head pattern	Chin	Scarpular pattern	Red head males
grandisquamis	+	60	+	Brown	♀ weak ♂ rare	♀ clear ♂ spotted	♀ large "mask" ♂ small "mask"	—
macrolepis .	—	50	+	♀ brown ♂ gray	Vivid	Black and White	♀ small "mask" ♂ very small "mask"	—
danforthi ..	—	50	+	♀ brown ♂ gray brown	♀ vivid ♂ rare	Blach & White red-head clear	♀ small "mask" ♂ very small "mask"	-
monensis....	—	50	—	Gray	Weak .	White . .	"spectacles"	—

NOTES

1. **Leonard Stejneger,** The Herpetology of Porto Rico, U.S.N.M. 1904, pp. 602–7.
2. **Thomas Barbour,** A Contribution to the Zoogeography of the West Indies with especial reference to Amphibians and Reptiles, Mus. C. Z. Vol. XLIV No. 2, March, 1914.
3. **Henry W. Fowler,** Some Amphibians and Reptiles from Porto Rico and the Virgin Islands. Acad. Sci. Phila. p. 7.
4. **Rep. U. S. Mus.,** 1902, p. 605, fig. 52.
5. **Thomas Barbour,** Notes on the Herpetology of the Virgin Islands. Pro. Biol. Soc. Wash. Vol. 30, p. 98.
6. **K. P. Schmidt,** Ann. N. Y. Acad. Sci. p. 184.
7. **Thomas Barbour,** Sphaerodactylus Mem. Mus. Comp. Zoo. Vol. XLVII, No. 3, pp. 253–5.
8. **K. P. Schmidt,** Scientific Survey of Porto Rico and the Virgin Islands. N. Y. Acad. Sci. Vol. X, pp. 70–4.
9. **Thomas Barbour,** A List of Antillean Reptiles and Amphibians, Zoologica, N.Y.Z.S., Vol. XI, No. 4, p. 83.

THE HERPETOLOGY OF CAJA DE MUERTOS ISLAND AND CARDONA KEY, PORTO RICO

CHAPMAN GRANT, Major, United States Army
and CORNELIUS ROOSEVELT

The interesting little Island of Caja de Muertos, Coffin Island, 8 miles off Ponce, Porto Rico, has been nearly ignored by herpetologists. It is not mentioned by Stejneger, 1904, in his "Herpetology of Porto Rico", or by Barbour, 1930, in his "A List of Antillean Reptiles and Amphibians". Schmidt, 1928, Vol. X, Part 1, "Scientific Survey of Porto Rico and the Virgin Islands" mentions *Anolis cristatellus, Ameiva wetmorei* and *Alsophis portoricensis* as the only forms known from the Island.

On July 26th, 1931, the joint writers visited the Island and secured the following 53 specimens, adding 3 species to the fauna, bringing the total to 6 species:

Anolis cristatellus, 21; very numerous and apparently not differing in habits or form from the mainland specimens.

Anolis pulchellus, 3; not abundant, but apparently not differing in form or coloring from the mainland specimens.

Ameiva exsul, 6; not abundant, seemingly the dorso-lateral stripes persist longer than in the mainland specimens.

Ameiva wetmorei eleanorae, 6; not abundant; described in this paper.

Sphaerodactylus townsendi, 17; not rare, differ slightly from the Vieques and Porto Rican specimens.

On August 20, 1931, we received a small collection comprising *Anolis pulchellus*, 3; *Sphaerodactylus townsendi*, 4; *Typhlops jamaicensis* sp. ?, 2; *Alsophis portoricensis*, 3; and *Phyllodactylus tuberculosus*, 1, adding 3 species to the fauna, bringing the total to 9 species.

On November 26, 1931, the senior writer again visited Caja de Muertos and captured 38 specimens:

Sphaerodactylus townsendi,	5;	*Ameiva wetmorei eleanorae*,	14;
Phyllodactylus tuberculosus,	1;	*Ameiva exsul*,	3;
Anolis pulchellus,	1;	*Typhlops jamaicensis, sp.?*,	2;
Anolis cristatellus,	11;	*Alsophis portoricensis*	1.

The *Alsophis* do not resemble the series of eight *A. portoricensis* in the Grant collection, but resemble the series of thirty *A. antillensis* in the same collection, in color and pattern but not in squamation.

The *Typhlops* appears to be distinct.

Barbour mentions *Phyllodactylus spatulatus Cope;* "Barbados collected years ago, about 1861, in fact, by Dr. Theodore Gill. I have no recent information as to its status". This is the nearest record of this genus to the present locality. The present find adds a genus to the Porto Rico fauna and a species to the Antilles.

On November 26, 1931, the senior writer visited Cardona Key, a tiny sand-coral islet bearing a light-house, off the harbor of Ponce. *Ameiva exsul* fairly swarms and *Anolis cristatellus* is numerous. Nine *Ameiva exsul* and three *Anolis cristatellus* were taken. *Exsul* exhibited a wide range of color and pattern, but no turquoise blue tails or red or salmon undersides were seen. Some specimens had light brown unmarked backs, others had two complete white lines below the dorso-lateral line along the sides, formed by the coalescence of white dots. *Critatellus* showed no markings and a plain olive fan.

Ameiva wetmorei eleanorae subsp. nov.

There are 135 specimens of *A. wetmorei* in the Grant collection from the neighborhood of Cabo Rojo, P. R. There is little variation in this series. The white stripes are narrow and there is a faint brown stripe between the mid-dorsal stripe and the continuation of the subocular white stripe. This brown stripe is the continuation of the subocular white stripe.

Type No. 2734, Grant Collection, July 26, 1931, Caja de Muertos Island, Porto Rico. Collectors, Roosevelt and Grant.

Diagnosis: Differs from *A. wetmorei* in having wider dorso-lateral white stripes. The supraocular white stripes usually stop at the base of neck instead of continuing on to tail as a brown stripe.

Habitat: Caja de Muertos Island, Porto Rico.

Proportions and squamation: As in *A. wetmorei.*

Color and pattern: The mid dorsal white line turns blue as it passes the sacrum. In the Muertos form this wide blue stripe includes an uneven, broken central black line from near the sacrum. In the Porto Rican form if the central black line occurs at all, it is much further down the tail. The supraocular white line usually stops at the neck in the Muertos form, leaving a jet black space between the middorsal white line and the continuation of the subocular white line. In the rare cases where this line continues in the Muertos form, it is merely as a faint white line. In the Porto Rican form, the supraocular white line turns brown at the shoulders and continues onto the tail. In the Muertos form the lowest white

line which runs from armpit to groin is as clear cut and distinct as those above it. In the Porto Rico form, the lowest white line is blurred or wider than the ones above it. The Muertos form has a much tidier clear cut pattern with more contrast.

WIDTH IN SCALES OF MIDDORSAL WHITE LINE AT

	scapular		midbody		sacral	
	min	max	min	max	min	max
A. wetmorei eleanorae	2	3	3	3⅓	3⅓	5
A. wetmorei	1	2⅓	1½	3	2½	4

AVERAGES OF THE ABOVE:

	scapular	midbody	sacral
A. wetmorei eleanorae	2.5	3.2	4.1
A. wetmorei	1.9	2.2	3.3
difference	.6	1.0	.8

Remarks: Specimens taken 20. Named in honor of the junior writer's Mother, Eleanor Roosevelt.

The habits of this species are mentioned by the senior writer in "Copeia", July, 1931.

THE HEMIDACTYLS OF THE PORTO RICO REGION

CHAPMAN GRANT, Major, United States Army

Two species of *Hemidactylus* are known to occur in the West Indies, *H. mabouia* and *H. brookii.*

There has been some misunderstanding in the classification of the *Hemidactylus* of Porto Rico and the adjacent islands of St. Thomas, Vieques, etc. The following scientists have listed *Hemidactylus mabouia* (Moreau de Jonnes) as occurring on Porto Rico:

1868 Cope, Proc. Phila. Acad. p. 311;

1881 Gundlach. Anal. Soc. Espan. Hist. Nat., X. p. 308;

1887 Garman, Bull. Essex Inst., XIX p. 18;

1893 Boettger. Kat. Rept. Mus. Senckenberg, I, p. 28;

1904 Stejneger. Ann. Rept. U. S. N. M. p. 599;

1928 Schmidt, N. Y. Acad. Sci., X. p. 69;

1930 Barbour, N. Y. Zoo. Soc. XI. p. 82.

I accepted the above evidence unquestioningly until my large series showed that a mistake had been made.

I doubt whether *H. mabouia* ever occurred on Porto Rico. Both Stejneger and Schmidt admit not having taken it. Stejneger describes a Cuban specimen of *H. brookii* in ascribing Porto Rico as the range of *H. mabouia.* Later students may have followed his lead. I believe that earlier writers did not have sufficient material for a correct diagnosis and that at present the distinction between the species is little understood.

My collection contains thirty-four *H. mabouia* from Vieques and five from St. Thomas. I have seen only *H. brookii* on Porto Rico.

Hemidactylus brookii Gray is listed by Barbour as occurring in Hispaniola and West Africa. My collection contains 99 specimens taken at San Juan, Río Piedras, Humacao, Caguas, Ponce, Playa de Ponce and Mayagüez, all on the island of Porto Rico.

KEY TO THE SPECIES OF *Hemidactylus* IN THE PORTO RICO REGION

a 1. Six rows of spines around base of tail, dorsal pattern, four black "Vs", femoral pores of males not interrupted at midline. St. Thomas and Vieques.—*H. mabouia.*

a 2. Eight or ten rows of spines around base of tail; dorsal pattern brown, mottlings or four rings; femoral pores of males interrupted at midline. Porto Rico.—*H. brookii.*

A detailed description of both species follows. The characters which differ in the two species are italicized for comparison.

HEMIDACTYLUS BROOKII

Based on a series of 99 specimens.

Diagnosis: A gecko of moderate size, the basal half of each digit expanded and provided beneath with several pairs of lamellae and *one large* distal lamella, the distal half compressed, arising from within the tip of the expanded portion, curved, and provided with a claw at the tip; *eighteen* rows of dorsal tubercles, keeled, radially ridged, *closely set;* the males with an *interrupted* series of *thirteen* pores on each femur; females without femoral pores; tail bearing whorls of *eight* spines near base, distally six; color *brown* when any is shown; markings when visible *four irregular rings,* shoulders to sacrum, or *marbled;* tail *marbled* with *brown;* rudimentary eyelid scalloped, *no spines;* head *triangular*, width at ears equals snout to *half* way between eye and ear. Redescription based on series of 99 specimens.

Habitat: Porto Rico where I have taken it at San Juan, Río Piedras, Caguas, Humacao, Ponce, Playa de Ponce and Mayagüez.

Proportions: Head triangular, width at ears equals snout to half way between eye and ear; otherwise normal.

Squamation: Rostral much broader than high, squarish, usually with a nick in the posterior margin for the anterior angle of the internasal and a median cleft extending forward for more than one half the height of the shield, in contact with two supernasals; first supralabial in contact with lower post nasal and reaching nostril; *nine* supralabials including the small posterior one, the *series ending* almost under the eye; top of head covered with granules interspersed with small, slightly *elongated, keeled,* and radially ridged tubercles spread about *five* granules apart, there being about *fourteen* tubercles from ear to ear; granules greatly enlarged on snout, especially on rostral canthus where they are about the size of *head* tubercles; eye equidistant between nostril and ear, its diameter being about one half its distance from tip of snout, *no* spines on rudimentary eyelid; ear opening elongate, oblique; mental triangular, as wide as rostral, *eight,* frequently *seven* infralabials, four chin shields, center pair much the larger, irregularly pentagonal, their anterior angle fitting into the corner between mental and *most* of *first* and *as frequently* first and *part* of *second* infralabials, broadly in contact with each other on the median line; several rows of elon-

gated scales border the lower labials. There is a considerable variation in the squamation of the throat and chin. Upper surface of body and flanks and hind aspect of legs covered with granules *like* those of head; upper surface *and flanks* bearing *eighteen* or *twenty*, rarely sixteen, fairly even rows of tubercles, strongly keeled and radially ridged, separated front to rear of same row by from *one and a half* to *six* granules; tubercles about three granules long, *no* wide strip of flank without tubercles; rear aspect of legs bearing scattered tubercles; throat covered with small flat uniform granules strongly contrasting with the imbricate cycloid scales of the rest of the underside and the anterior aspect of the legs and extending along sides of tail and seven or eight rows beyond vent, being *smaller* than the dorsal tubercles; anterior to the vent there is a diamond shaped escutcheon of enlarged scales; in the males three, in the females one, outer series of scales under the thighs is enlarged, and in the males only, the outer scales bear a narrow pore extending across the upper part of the scale, there being about *thirteen* such pores on each femur, the series *interrupted* by one scale at the midline; a longitudinal umbilical scar is *sometimes* discernible, anterior to the escutcheon; fingers and toes free, all with long, compressed angularly raised and clawed distal phalanges; basal dilated portion with lamellae, a *large* single one at distal end of a series of four to seven paired ones; tail subcylindical, a groove above extending from base nearly to tip, upper half covered with striated scales slightly larger than the granules of the back and at the base of tail *four* and sometimes *five* rows of long pointed radially ridged spines in whorls on each side of tail, beyond fourth whorl usually only three rows of spines on a side; whorls about *six* scales apart and spines about breadth of *four* scales, scales surrounding each spine slightly enlarged, tail *not* enlarged at whorls, underside either with a median series of large plates about two to a whorl, *or* a *paired* series of plates *or tongue shaped scales;* a regenerated tail is covered with scales *somewhat larger* than dorsal granules and is without whorls or spines, but does have irregular large median scales on underside and the groove above.

Color and Markings: Color and markings usually show in this species: distinctly brown above and finely dotted below. The illustration shows the extreme in pattern, usually this is broken up into somewhat irregular marbling; all color due to concentration of fine black or brown specks; a distinct transocular dark line bordered above and below with a light line of equal width; lamellae distinctly ash gray; a regenerated tail may be marbled above with brown sim-

ilarly to dorsal pattern. Young: The tail is banded dark and salmon, body frequently not noticeably more pigmented than adult; frequently very dark, the four dorsal rings outlined by light tubercles.

I took a baby *Hemidactylus* 31 October, 1931, by placing my finger tip on his head. He raised his tail and waved it and the end broke off without touching any object. Tail banded black and salmon. Upper surface of body almost black with four rings of light yellow dots, shoulders to sacrum. A few light dots scattered but none within the rings. Specimen taken in broad daylight. By dark it had turned lighter color inside the rings, making four light discs. By 9:30 P.M. he had turned lighter except for four dark rings corresponding to the four rings of yellow dots. The feet were flesh color. By next morning, although kept in a dark drawer, he had turned as dark as when captured. This specimen did not at any time turn any where near as light as specimen No. 3510 taken at night. This last was as light as a "colorless" adult except for the black and salmon rings.

Remarks: When caught by hand this little gecko frequently gives a squeak. Specimens taken 99, of all sizes.

Through the kindness of Dr. Stejneger and Miss Cochran of the National Museum three specimens of *H. brookii* were made available to me for comparison. They appear to be the same species that occurs on Porto Rico, but vary in a few particulars beyond the range of variability of the Porto Rican specimens. Especially are they noticeable in bearing more closely-set and heavier spines in the pelvic region.

The following table brings out a few differences, but it is to be borne in mind that it is a comparison of a series of 99 with three specimens.

Hemidactylus brookii	Porto Rico series of 90 specimens	U. S. N. M. 42507 Uganda, Africa	U. S. N. M 42175 Wadelai Nile, Africa	U. S. N. M 28992 Bacow P. I.
Femoral pores interrupted at center by	1 scale	3 scales	4 scales	5 scales
Spines in ear	none or very small tubercles	blunt spine	1 long spine	none
Pattern	typical	typical	typical	obliterated
bare flank strip..... granules in width	3–6	none	none	4–5
mental wider than rostral	no	slightly	yes	much
rows of dorsal tubercles	18	18	18	18
separated by..... granules	1½–6	1–3	2	2–3

HEMIDACTYLUS MABOUIA

Based on a series of 41 specimens.

Diagnosis: A gecko of moderate size, the basal half of each digit expanded and provided beneath with several pairs of lamellae between *small* single ones, the distal half compressed, arising from within the tip of the expanded portion, curved, and provided with a claw at the tip; *twelve* rows of dorsal tubercles spaced from *one* to *four* times their width apart, strongly keeled and radially ridged; the males with an *uninterrupted* series of *sixteen* or *seventeen* pores on each femur; females without femoral pores; tail bearing whorls of *six* spines; color *gray;* when markings are visible six black "V" shaped, point to the rear, cross bands, head to sacrum; tail barred with black at every fourth whorl of spines; one or more small *spines* along rear edge of rudimentary eyelid. Head normal, width at ears equal to snout to *one-third* distance between eye and ear. Diagnosis and description based on entire series of 41 specimens.

Habitat: Vieques and St. Thomas Islands. Found around old buildings at night.

Proportions: More slender than *H. brookii;* width of head at ears equal to snout to one-third distance between eye and ear.

Squamation: Rostral much broader than high, squarish, split nearly to lip, bordered above by supernasals and the anterior of two small scales between the latter; first supralabial in contact with lower postnasal and reaching nostril; about *twelve* supralabials including the small posterior one, the *ninth* under the center of eye; top and sides of head covered with fine granules interspersed with small, *circular*, radially ridged, *unkeeled* tubercles, spaced about *seven* granules apart, there being about *eighteen* tubercles from ear to ear; granules greatly enlarged on snout, especially on rostral canthus where they are nearly the size of *dorsal* tubercles; eye equidistant between nostril and ear, its diameter being about one-half its distance from tip of snout, *one* or *more distinct black tipped spines* on posterior part of rudimentary eyelid; ear opening elongated, oblique; mental triangular, as wide as rostral, *nine* or *ten* infralabials; four chin shields, center pair much the larger, irregularly pentagonal, their anterior angle fitting into the corner between mental and first and *nearly always* part or second infralabials, broadly in contact with each other on the median line; several rows of elongated scales border the lower labials. There is a considerable variation in the squamation of throat and chin. Upper surface of body and flanks and hinds aspect of legs covered with granules *larger* than those of

head; upper surface of body bearing *twelve* fairly even rows of tubercles, strongly keeled and radially ridged, separated front to rear of same row by from *four* to *eight* granules; tubercles about three granules long; a *wide strip* of flank bears *no* tubercles; rear aspect of legs bearing scattered tubercles; throat covered with small flat uniform granules, strongly contrasting with the imbricate cycloid scales of the rest of the underside and the anterior aspect of the legs and extending along sides of tail and seven or eight rows behind vent, being the *size of* or frequently *larger than* the dorsal tubercles; anterior to the vent there is a diamond shaped escutcheon of enlarged scales; in the males three and in the females one outer series of scales under the thighs is enlarged, and in the males only, the outer scales bear narrow pores extending across the upper part of the scales, there being *sixteen* or *seventeen* such pores on each femur, the series *not* interrupted at midline; a longitudinal umbilical scar is visible anterior to the escutcheon; fingers and toes free, all with long, compressed angularly raised and clawed distal phalanges; basal dilated portion with lamellae, a *very small* single one at each end of a series of four to seven paired ones; tail subcylindrical, a groove above extending from base nearly to tip, upper half covered with striated scales slightly larger than the granules of the back and *three* rows of long pointed radially ridged spines in whorls on each side of tail; whorls about *seven* scales apart and spines about the breadth of *three* scales, scales surrounding each spine slightly enlarged, tail *enlarged* at each whorl, underside *always* with a median series of large plates which begins below the seven or eight rows of pointed scales and possibly one or two divided plates, about two to a whorl; a regenerated tail is covered with scales about *four times* the size of dorsal granules and is without whorls, spines, enlargements or large lateral cycloid scales, but does have the large median plates on underside and the groove above.

Color and markings: No sexual dichromatism apparent; most specimens show little color. Whether because they are killed when pigment is not on surface or because of being killed at night I do not know. When pattern shows at maximum; upper surface gray, snout brown, marbled, six black cross lines, head to sacrum, somewhat "V" shaped, point to rear, dorsal tubercles black dotted, a black band at every fourth whorl on tail; no transocular dark line; a regenerated tail is speckled, but no marblings appear. Underside: clear white save for a few minute dots on lower labials and mental and tail; lamellae very dark gray, very noticeably in contrast to underside of body. Young: Same pattern above, but very dark as

a whole, due to fine black dots; underside dark from multitude of fine black dots; labials and side of head noticeably marked with white or cream colored dots.

Remarks: Specimens taken, 34 from Vieques, 7 from St. Thomas.

Through the kindness of Dr. Stejneger and Miss Cochran, of the National Museum, I have been able to study 10 specimens of *Hemidactylus* from each of Cuba 3; St. Thomas 3; Barbados 2; Guadeloupe 1; Antigua 1.

The specimens from Cuba, U.S.N.M. Nos. 75843, 27630–1 catalogued as *H. mabouia* are in reality *H. brookii.* The rest are *H. mabouia.* One specimen U.S.N.M. 11186 differs in having the dorsal tubercles noticeably flat. Otherwise it agrees in all particulars.

Conclusion: I have definitely identified *H. brookii* from Porto Rico and checked specimens from Africa, The Philippines and Cuba as of this species. I have identified *H. mabouia* from Vieques and St. Thomas and checked specimens from Barbados, Antigua and Guadeloupe as of this species.

Careful search has failed to reveal any *Hemidactylus* on Mona, Culebra or Caja de Muertos Islands. The inhabitants maintain that this lizard does not exist on their islands.

Note: I am indebted to Miss Adrienne Serrano of Vieques for most of my series from that island, and to Mrs. Heiberger of St. Thomas for the specimens from St. Thomas.

EXPLANATION OF PLATE X

Fig. 1.—*Hemidactylus brookii.* Note pattern of rings and the coarse tubercles.

Fig. 2.—*Hemidactylus mabouia.* Note chevron shaped pattern and small tubercles.

Fig. 3.—Young *H. mabouia.*

PLATE X.

1. 2. 3.

THE INITIATION OF AN INSECT PEST SURVEY IN PORTO RICO *

By M. D. LEONARD, Entomologist, Insular Experiment Station, Río Piedras, Porto Rico.

ABSTRACT

A brief account of the initiation of periodic observations and reports on the more important and injurious insects in Porto Rico in cooperation with the Insect Pest Survey office of the United States Bureau of Entomology. Faunal studies, both past and present are referred to and methods of collecting and recording Survey data are described. The objects of an Insect Pest Survey and the benefits to be derived from such work, both local and international, are suggested.

PREVIOUS FAUNAL STUDIES

Basic to an Insect Pest Survey in the strict meaning of the term is a thoro knowledge of what insects occur in the State or Country under consideration. Dr. L. O. Howard once stated that "All entomology is economic entomology." Since this is fundamentally largely if not entirely true, before the injurious or non-injurious nature of all the various species present can be properly evaluated, it is first highly desirable to know just what species comprise the insect fauna and their distribution, both geographical and seasonal. All studies, therefore, that have contributed towards such an end help to lay a valuable foundation for a detailed Insect Pest Survey of the territory.

Much work of this nature has fortunately been done in Porto Rico. The early accounts of Porto Rican insects by Fray Iñigo Abbad in 1788 and Andrés Pedro Ledru in 1810 followed by the extensive collections and studies of Dr. Augustín Stahl published in 1882 and of Drs. Leopold Krug and Juan Gundlach (1887–1893) form the basis of our knowledge of the insects of the Island.

In 1903 a Federal Experiment Station was established at Mayagüez and from then until 1924 several well-known entomologists, notably W. V. Tower, C. W. Hooker and R. H. Van Zwaluwenburg did much to increase our knowledge of the insects of the Island. In 1914 Van Zwaluwenburg compiled a typewritten list of the all insects recorded in Porto Rico to date with a supplement the fol-

* This paper was read before the 3rd Annual Meeting of the Eastern Branch of the American Association of Economic Entomologists held in New York City, November 19–20, 1931.

lowing year. The Sugar Producers' Association established an Experiment Station in 1910 at Río Piedras which was reorganized three years later as the present Insular Experiment Station. For the past twenty years in this Station a great deal of data on Porto Rican insects has been accumulated by a number of well-trained workers, especially Van Dine, T. H. Jones, C. H. Hood, Crossman, Smyth, G. B. Merrill, Cotton, Wolcott, Seín and Dozier. In 1924 Wolcott published his "Insectae Portoricensis" in which he listed all of the insects known to occur in the Island with notes on their distribution and food-plants. In this a total of upwards of 2500 species are mentioned. It is a most useful piece of work.

In 1913 the New York Academy of Science in cooperation with the Porto Rican government conceived a plan of making a complete Scientific Survey of Porto Rico and the Virgin Islands. For several years beginning in 1914 a large number of insects were collected by F. E. Lutz, H. E. Crampton, A. J. Mutchler, C. W. Leng, F. E. Watson, H. G. Barber, L. B. Woodruff and others for inclusion in the reports of the Survey later on. To date a report has been published on part of the moths by Forbes and a report on the Diptera by Curran and a supplement to each has appeared during 1931. The preparation of the reports on most of the other major orders of insects is well along so that in the course of a few years we will have a good basic knowledge of the insect fauna of the Island.

INITIATION OF A FORMAL INSECT PEST SURVEY

All of the above, however, is still not sufficient. In Porto Rico as in all other places we need to know not only what insects constitute the fauna but also the feeding habits of each, its seasonal and geographic distribution and its relative abundance during different parts of the year. Such information can be obtained only by systematic, frequent and continued observations made over a considerable period of time.

The writer has been greatly interested in the Insect Pest Survey conducted under the very able direction of Mr. J. A. Hyslop in the U. S. Bureau of Entomology ever since its inception in 1921 and for the first few years while stationed in New York State was an active collaborator in this work. Shortly after coming to Porto Rico in January 1930 he was appointed an Official Collaborator of the Survey and began to make observations with that end in view. For many years, in fact since 1911, insect records at the Insular Experiment Station had been kept on so-called accession cards, each of which

contains the notes in connection with specimens placed in the collection. Each card bears a serial number of that year corresponding with the same number on the pinned specimens in the collection. The disadvantage of this method of keeping records for the purpose of an Insect Pest Survey is that the accession cards are filed numerically and not by the names of the insects; also that unless notes are accompanied by actual specimens in the collection they really have no proper place in the file. This has made it difficult to determine what observations have been made on any given insect since the close of Wolcott's "List" in 1923 and further it is not necessary or desirable to continue to place specimens of many common and well-known insects in the collection each time an observation is made concerning them.

At the Cleveland meeting of the American Association of Economic Entomologists in December 1930 Mr. Hyslop presented a brief paper showing how any entomologist could institute a simple record system for keeping track of observations on the activities of injurious insects in his territory (See Jour. Econ. Ent. **24**(2): 463–465, 1931) and offered to supply to anyone desiring them the standard record blanks in use in his office in Washington. Such a set of blanks was therefore obtained and the systematic recording of all observations possible on injurious insects in Porto Rico was commenced early in 1931. The accession card catalog has been kept up at the Station but is now used only where specimens are preserved in connection with individual observations and even in all such cases the notes are also entered on the regular Survey record blanks.

By this system the whole process of recording and filing observations after they are made is surprisingly simple. In this way nothing of value is lost and many new and interesting records have already been obtained. Such records as were accumulated during 1930 (mostly during the second half of the year) were transferred to the standard record blanks and included in the file. Altho the Survey work has been a minor project of the Division of Entomology at the Station and not a great deal of time has been given to it we have been able to record in a little more than a year well over 500 individual observations on nearly 150 species of more or less injurious insects, distributed in over 100 genera. A number of species have been watched from month to month in order to determine more accurately their peaks and low points of activity. This is only the start. Its scope is continually expanding as we work with it.

METHODS OF OBTAINING DATA

The methods of obtaining data are possibly for the most part no more than the obvious ones but they may be worth while mentioning. The two members of the staff at the Station at Río Piedras and Dr. Wolcott at the Sub-Station at Isabela make observations during trips on the Island and also locally on crops grown at or near the two Stations. Conversation or correspondence with at least certain members of the Division of Agricultural Extension in various parts of the Island and with the Superintendents of the Department's Experimental Farms bring to light many interesting notes. General correspondence from farmers and home-owners has also turned up much of value. Beginning July 1, 1931 several Specialists were appointed at the Station to cover work with most of the different crops grown in the Island. These men will make many observations as time goes on in the course of their official travels and indeed have already supplied some very worth-while data. A fertile source of information has been the local office of the U. S. Plant Quarantine & Control Administration whose staff have made many interceptions since 1925 of injurious insects in Porto Rico both in the field and from fruits and vegetables offered for shipment to the Mainland. Such material has all been determined, wherever necessary, by the Specialists in the U. S. National Museum. From July 1930 thru October 1931 these interceptions included over 300 individual records on about 75 species distributed in about 60 genera, most of which were more or less injurious to crops.

Mr. Hyslop has suggested that the object of an Insect Pest Survey is to collect accurate and detailed information on the occurrence, distribution, ecology, and relative abundance of insect pests throughout the territory involved and to study these data from month to month and year to year with relation to the several factors that influence insect abundance. The results to be obtained from a survey of this nature, undertaken for a series of years are manifold; we should be able to throw light on the reasons for the cyclic and sporadic appearance of insect pests, the gradual shift of regions of destructive abundance, the limiting barriers to normal dispersal and the directive influences that determine the paths of insect diffusion. This is the necessary foundation for any advance toward the possibility of entomological forecasting.

THE BENEFITS OF INSECT PEST SURVEYS

To further expand this suggestion: An attempt is being made to complete a picture. This is a mosaic however and as the years go on each record supplies a tile which fits into its proper place to help make up the whole. If enuf records could be obtained in a sufficient number of places with varied conditions and taken over a sufficient period of time much light would undoubtedly be shed upon insect activities which would prove of increasing practical value as time went on.

Intensity maps could be gradually filled out which, if properly correlated with temperature, humidity and rainfall would go far to show the effect of these factors on insect abundance. Further: altho breeding is more or less continuous in many places thruout the Tropics, it is well-known that in Porto Rico and also certain other places some insects, at least, are more abundant during the summer months, while others are more numerous in the winter season. This is in spite of the fact that the average mean temperature in Porto Rico, for example, varies but little from month to month. Reliable and continued observations on certain selected insects would do much to explain this phenomenon. Such observations should of course be correlated with data on the seasonal abundance of favored food-plants and other pertinent factors.

A more immediate value of Survey work is possibly the building up of definite data on the infestation of certain crops, positive or negative, which at once becomes of considerable value when plant quarantine questions arise. This has been shown very clearly during the past two years in Porto Rico and in those cases where sufficient conclusive evidence was lacking we wished greatly that a systematic Insect Pest Survey as such, had been in progress for a much longer time.

The writer has supplied to the office of Insect Pest Survey in Washington, besides a monthly report on insect conditions in Porto Rico, a summary report for both the fiscal years of 1929–30 and 1930–31. The former was published in the Annual Report of the Division of Entomology of the Insular Experiment Station for that year (pp. 110–123, 1931) and the latter will be published in the Jour. Dept. Agr. Porto Rico, **16** (2) for April, 1932. This could also be done in other places to the great mutual advantage of both the Country concerned and the United States. If periodic monthly or bi-monthly, or even semi-annual or annual reports could be prepared by a competent person in a number of foreign countries and a copy

sent for file in the office of Insect Pest Survey in Washington in exchange of the monthly bulletin of that office a great mass of most valuable data could be accumulated of benefit to all concerned.

Such periodic reports should be encouraged and the necessary cooperation obtained from the proper officials, especially to start with in those countries which export the greatest variety of fruits and vegetables and other crops to the United States. It is encouraging to note that for the first time since the start of the Federal Insect Pest Survey reports have been received and published during this past year in the Insect Pest Survey Bulletin from places outside the mainland of the United States. These include one or more each from Hawaii, Mexico, Cuba, Honduras, Guatemala, Costa Rica, Haití, Dominican Republic, Antigua (B. W. I.) and China in addition to Porto Rico. I understand from Mr. Hyslop that cooperation is now being solicited in addition to the above, from Peru, British Guiana, the State of Minas Geraes in Brazil, as well as several of the British West Indies for Survey reports during the coming year.

Regular commercial travel by airplane between the mainland of the United States and the West Indies and Central and South America is growing so rapidly that it is sure to greatly increase trade in plants and plant products with the United States. This will obviously augment plant quarantine problems and increase the necessity for a more accurate knowledge of the insect pests of all the countries concerned. Well-organized Insect Pest Surveys will supply the necessary information. They will of course be of value insofar as they are conducted with consistency and thoroness but any and all information that is accumulated will be well worth the effort spent in obtaining and recording it.

THE PINK BOLLWORM OF COTTON IN PORTO RICO *

By M. D. Leonard, Entomologist, Insular Experiment Station, Río Piedras, Porto Rico.

ABSTRACT

The introduction, spread and present status of the pink bollworm, *Pectinophora gossypiella* Saunders, in Porto Rico are described. In order to understand the somewhat unusual conditions under which the insect is working in the Island the essential climatic and topographic features and the development of Sea Island cotton growing in Porto Rico are briefly outlined. Attempts at control are discussed together with the relation of alternate host plants as a factor in carry-over of the insect from one crop to another.

CLIMATE AND TOPOGRAPHY

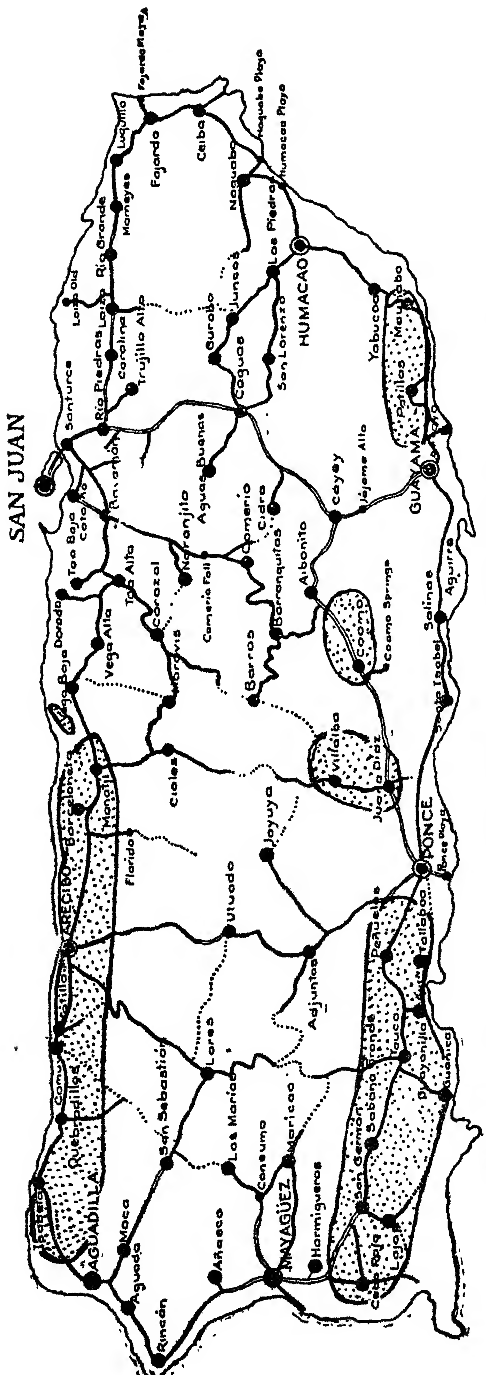
In order to gain an intelligent understanding of the pink bollworm problem in Porto Rico it is desirable to know something of the essential climatic and topographic features of the Island and of how the Sea Island cotton crop is grown there.

Porto Rico is about 90 miles long by 40 miles wide with an area of nearly 3600 square miles. It is roughly rectangular in shape, the long axis being East and West. In general the whole Coastal area is an irregularly narrow, fairly level strip, but the Island is for the most part very hilly, with a central chain of mountains running lengthwise, but nearer the South Coast, several peaks of which rise to over 4000 ft. above sea-level. The mean annual temperature is about 78°F. for the Island as a whole, there being but little difference between winter and summer temperatures. The rainfall for the whole Island averages about 71 inches for the year but differs greatly in different sections: the South Coast having about 45 ins. and the North Coast about 65 ins. The trade winds blow almost continuously in an easterly direction, thus concentrating the rainfall in the sections North and East of the mountains.

COTTON IN PORTO RICO

There are two distinct cotton growing regions in Porto Rico—the North Coast and the South Coast sections. The North Coast section extends in an almost continuous strip from Aguadilla at the Northwest corner of the Island as far as Arecibo and in more spotted

* This paper was read before the 44th Annual Meeting of the American Association of Economic Entomologists held at New Orleans, La., December 29–31, 1931.



MAP OF PORTO RICO SHOWING PRINCIPAL COTTON GROWING AREAS, 1930–1931

patches eastward almost to Vega Baja, being confined to the more level coastal lands. In the South Coast the principal section is from Cabo Rojo at the Southwest corner westward almost to Ponce. This is mostly at a fairly low level near the coast. This past year considerable cotton was also grown at Patillas and Maunabo, both near the coast. There are however important plantings at Villalba and Juana Díaz and at Coamo which are at higher elevations. Cotton was grown in 1931 at Villalba at at least 600 feet elevation, which is undoubtedly the highest point at which Sea Island cotton has ever been cultivated anywhere in the world. (See accompanying map showing cotton growing areas in 1930–1931.)

Only Sea Island cotton is grown. This type was first cultivated commercially in Porto Rico, along with several other types in 1861 due to reduced acreage in the United States on account of the Civil War. Various types of cotton have however been long grown in Porto Rico and the plant was cultivated by the aborigines prior to the arrival of Columbus in 1493. In 1736 sugarcane, coffee and cotton were the three most important crops and in 1776 over 100,000 lbs. of cotton were produced. In 1837 it is stated * that a little over 1 million pounds of cotton were shipped out of the Island. This production greatly declined during the ensuing years however due to increase of the crop in the Southern United States.

Since 1924 there has been a steady increase in acreage in the North Coast from 6500 acres to 1100 in 1931. In the South Coast however there were about 5000 acres yearly from 1924–26; it fell off greatly in 1927 but was up to 4500 acres in 1930 and in 1931 increased to 9,000 acres, thus making a total of 20,000 acres for the Island as a whole. This makes Porto Rico the largest Sea Island cotton growing section in the world.

For several years now all the cotton has been grown under contract for the San Juan Ginnery Co. which is subsidiary to J. & P. Coats Ltd. of Glasgow and the Clark Thread Co. of Newark, N. J., for export. The Company provides free seed and advances money for fertilizers, insecticides and cultivation expenses to the growers, all advances being deducted from the returns from the crop at harvest time.

THE PINK BOLLWORM SITUATION

The pink bollworm was first discovered in Porto Rico in July 1921 at Humacao at the East end of the Island. An immediate sur-

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* By Fray Iñigo Abbad y Lasierra in his Historia Geográfica, Civil y Natural de la Isla de Puerto Rico, p. 326, Madrid, 1788 (New Edition, Acosta, Porto Rico, 1866).

vey following its discovery showed that the insect was present in all the important cotton growing sections. In the spring of 1922 the infestation was practically confined to the coast or its immediate vicinity but a year later infested plants (mostly wild cotton) could be found considerably inland in several sections.

The insect is thot to have been introduced with seed brought from St. Croix in 1920 which was widely distributed thruout the Island.

As far as can be determined the pink bollworm, altho present in all the cotton growing areas in the Island since 1921–23, was not any appreciable factor in the production of the crop until 1931. It is stated that the late crop in 1925 around Aguadilla was damaged from 3–5 per cent. In the crop harvested in 1930, for example, a light infestation could be found in many fields but this was mostly confined to the last picking and did but little damage. In 1931, however, caterpillars were present in almost the first picking of the earliest fields observed during the fore part of January in the South Coast. Continued observations showed that the infestation increased until by the end of the crop in April and early May many fields could be found in the South Coast with as high as 95 to even 100 per cent of the bolls infested. It is estimated that there was at least a reduction of 15 to 20 per cent of the crop on account of the pink bollworm and it actually was probably even greater than that.

In the North Coast section the situation was somewhat the same and for the first time also. One very early planted field examined at Hatillo on May 5, 1931 was so badly infested at the time that it was reported to have been practically worthless two weeks earlier. Another field, for example, near Aguadilla showed a high infestation in the first crop in June, often two or three caterpillars being found in one boll or a large caterpillar in a small boll.

ALTERNATE HOST-PLANTS

The question of alternate host-plants is an important one in Porto Rico since they produce fruit continuously thruout the year thus making possible continuous breeding of the pink bollworm thruout the year. Wild tree cotton is rather thinly but widely distributed thruout all sections despite several previous efforts to eradicate it. Especially in the South Coast it is a constant menace to the cultivated Sea Island crop, where less thoro clean-up work has been done than in the North Coast cotton growing sections.

In 1923 it is reported that the then Agricultural Agent in Camuy found the fruits of the maga tree, *Montezuma speciosissima* infested by pink bollworm larvae. Apparently almost no further ob-

servations on this tree as an alternate host were made until this past year. On May 5, 1931 Mr. U. C. Loftin and the writer collected 50 fruits from a tree near Aguadilla of which 2 were infested, each containing a live larva. Dr. Geo. N. Wolcott states that early in October, after most of the crop had been harvested he found maga fruits as high as 70 per cent infested, with often two or three larvae to a fruit. This tree is undoubtedly an important factor in maintaining the pink bollworm population between one cotton crop and another. It is common at the lower elevations, especially in the Central and Western parts of the Island. It has been extensively planted along the main coastal roads for ornament and shade, since it has showy crimson flowers and large dark green leaves and often reaches a height of 40–50 feet. The fleshy fruits form thruout the year. Besides being used for shade and ornament the wood is said to be used for furniture, musical instruments, posts and the like and it is claimed that hardship would be caused by having these trees destroyed in the cotton growing areas.

Another Malvaceous tree, locally called the "emajaguilla," *Thespesia populnea,* is also an alternate host of the pink-bollworm but it is of relatively minor importance. Mr. Loftin and the writer examined fruits in several localities on May 4 and 5, 1931, with negative results but one sample of 50 fruits collected near Yauco on May 4 had one which contained a live bollworm. This tree is more common in some sections of the Island than the maga and grows well up in the mountains as well as in the coastal sections along the main roads. It seems to have a more definite fruiting period than the maga.

During the past year it has been established by inspectors of the U. S. Plant Quarantine & Control Administration and by Dr. G. N. Wolcott that okra growing near badly infested cotton is liable to infestation. Dr. Wolcott's observations further show that even the very small marketable pods only a few days old, become infested when the plants are growing near badly infested cotton but that infestation does not occur when the cotton is only moderately infested.

ATTEMPTS AT CONTROL

Very soon after the discovery of the pink bollworm in Porto Rico a project was outlined to destroy all the wild tree cotton, especially in the Eastern end of the Island—the original place of the discovery of the insect, but was abandoned when the distribution of the pink bollworm was found to be so extensive.

Since that time all cotton seed has been fumigated at the San Juan Ginnery Company's gin at Martín Peña, which is the only gin in use on the Island. The standard carbon bisulfide treatment has been used at the rate of 1 lb. per 80 cu. ft. for at least 24 hours. The fumigation rooms are tight and the work is done under the immediate supervision of an inspector of the Insular Plant Quarantine Service. As far as we have been able to determine this fumigation has always been highly effective.

As before stated it has been estimated that at least part of the crop of 1925 was damaged from 3–5 per cent. During this year the Porto Rican Legislature passed a law empowering the Commissioner of Agriculture to declare cotton a public nuisance during certain specified periods of each year. These were set as follows: for the South Coast from May 15 to July 30 and for the North Coast from October 15 to December 31. This law provided for the destruction of all Sea Island cotton by the start of the "closed season" and wild cotton was declared to be a public nuisance during any time of the year.

Some effort has been made each year since that time to carry out this law but for various practical reasons only partial success has been obtained. The great increase in the amount of damage to the crop, harvested in 1931, however, greatly stimulated efforts to make the closed season for Sea Island cotton and the destruction of wild tree cotton more effective. A series of meetings were held in each of the ten principal cotton growing towns in the South Coast the week of April 20th. These were well attended by the cotton growers and at each meeting representatives of the Insular Experiment Station, of the Agricultural Extension Division and of the San Juan Ginnery Co., attempted to explain exactly the meaning of the closed season and the reasons for it. Despite this effort on the part of those charged with the wellfare of the cotton growers, success was only partial. It was estimated that by May 15, the date set for the start of the closed season and therefore of the completion of the destruction of the old crop, only about 5 per cent of the old crop remnants had been destroyed. By June 1 about 50 per cent of the old plants had been pulled out and destroyed and it was not until the end of the month that the work was anything like even fairly well accomplished. Little had been done by that date however in the Guayama–Maunabo section where the crop had been planted late. Wild cotton had been cut down and destroyed to a large extent but in some places little had been done by the end of June and much still remained even by November 1st. It is thus seen

that the theoretical "no cotton" period of three and half months was cut down to at best not more than one month and even at that a great many wild tree cotton plants were never destroyed at all.

In the North Coast the closed season for 1931 was advanced to October 1 this year and altho the growers in this section have always been more progressive, since they have been more dependant on cotton as a cash crop, the results to date have been far from satisfactory. It is estimated that by October 20 about 75 per cent of the old cotton plants have been pulled out but of these only about one-third have been burned. Very little of the clean-up work had been accomplished by October 1st but this was said to be because of the understanding among many growers that the closed season was not to start until October 15 as previously agreed. The clean-up has apparently been good in Camuy and fairly complete in Isabela but poorest in Hatillo and Vega Baja, which latter two localities were undoubtedly the worst infested during this past year.

Due primarily to differences in the distribution of rainfall but also to differences in the distribution of available labor the planting, growing and picking seasons for cotton are quite different in the two principal sections. This is shown in the following table.

TABLE 1

SHOWING PLANTING, PICKING AND CLOSED SEASON IN THE COTTON AREAS OF PORTO RICO

(PREPARED BY J. PASTOR RODRÍGUEZ)

Cotton Section	Planting	Picking	Closed Season
North Coast	January, February and to March the 15th	June, July, August and September	From October 10 to January the 1st
South Coast	August and September	February, March, April and May	From May 15 to August the 1st.

Because of the difference in planting season in the North and South Coasts commercial plantings of cotton are growing in the Island during every month in the year. It has therefore been most emphatically suggested by Mr. Loftin, during this past year that the planting season by synchronized in both the North and South sections, thus permitting a "no cotton" season for the whole Island at the same time. This is highly desirable if not absolutely essential to successful pink bollworm control but for various practical and economic reasons it seems impossible of accomplishment at present. In such an event, however, it would probably be best for the North Coast to change to the planting season of the South Coast but the seasonal distribution of labor and of alternate crops seem to be strongly

against making such a radical change. Another alternative advanced is that the South Coast abandon the growing of cotton entirely. This many growers do not wish to do even with a price of not more than 6¼ cents a pound guaranteed for first grade-seed cotton for 1932.

It has recently been proposed to take a holiday from cotton growing in the Island for 1932 but neither does this proposition does find favor among many growers and also the crop in the South Coast had already been planted.

For various practical reasons, therefore, the successful carrying out of possible measures for the suppression of the pink bollworm looks rather dubious and it is anticipated that considerable loss to the crop may result during the coming year. There have been planted only about 1400 acres in the South Coast for the coming crop as against 9000 acres this past year and it is estimated that the North Coast crop will be much less than the acreage of 1931. The pink bollworm infestation has built up to an alarming extent during the past year and for this coming year there may be at least as many if not more worms present to infest less than one-sixth of the previous acreage in the South Coast and not more than one-half the previous acreage in the North Coast.

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1931. **Torres, I. L.** Campaña contra el gusano rosado del algodón. Rev. Agr. P. R. **26** (9) : 175–176.

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1931. **Wolcott, G. N.** The infestation of young okra pods by pink bollworm in Porto Rico. Jour. Dept. Agr. P. R. **15** (4) : 395–398.

ADDITIONAL REFERENCES TO THE BEAN LACE BUG

By M. D. Leonard,
Entomologist, Insular Experiment Station, Río Piedras, P. R.

In the Journal of the Department of Agriculture of Porto Rico **15**(3) : 309–323 there was published a paper by M. D. Leonard and A. S. Mills entitled "Observations on the bean lace-bug in Porto Rico". A bibliography of 44 titles was included which was intended to be as complete an index as possible to *Corythucha gossypii* Fab. in literature. Mr. S. C. Bruner, Chief of the Department of Phytopathology of the Cuban Agricultural Experiment Station has been good enough to call our attention to several references which we overlooked. They are as follows:

Anonymous (presumably J. R. Johnston). El insecto que ataca la higuereta y modo de combatirlo. Rev. Agr. Com. y Trab. (Cuba) **1**(10) : 531–533, 2 figs. October, 1918.

An official report by the Comisión de Sanidad Vegetal (now Sección de Sanidad Vegetal) on *C. gossypii* as a pest of the castor oil plant, control experiments are included; the adult is figured and spraying operations are shown in a photograph; nicotine sulfate and soap were used successfully.

Barthe, A. E. Cultivo industrial de la higuereta, Rev. Agr. Com. y Trab. (Cuba) **2**(3) : 93–95. March, 1919.

The secton relating to pests of the castor oil plant includes *C. gossypii* as an important pest; evidently largely compiled from previous work.

Bruner, S. C. Un honguillo parásito del Tingítido de la higuereta. Rev. Agr. Com. y Trab. (Cuba) **2**(5) : 218–219, May, 1919.

Relative to the fungus, *Sporotrichum*, parasitic on *C. gossypii* on the castor oil plant.

Bruner, S. C. Informe del departamento de entomología y fitopatología. Ejercicio de 1929 a 1930. Est. Exp. Agr. Cuba, p. 28.

Mentioned as a lima bean pest.

Cardín, Patricio. Plagas de la higuereta en Cuba. Rev. Agr. Com. y Trab. (Cuba) **1**(10) : 527–531. October, 1918.

Largely concerning the *Corythucha*, a serious pest of the castor oil plant; also lists the insect, in their order of being attacked, on: red pepper, soursop, peanut, kidney bean (fríjol) squash, ramie and aguinaldo (*Turbina corymbosa* (L.) Raf.).

Cardín, Patricio. Informe del departamento de entomología y patología de 1917 y 1918. Est. Exp. Agr. (Cuba) pp. 460–461. 1919.

In the report of the Department of Entomology experiments are mentioned for the control of *C. gossypii* on castor oil; soap is effective.

Mr. Bruner also writes that he has taken *C. gossypii* in small numbers on the leaves of banana in addition to some of the plants mentioned in the paper by Mr. Mills and myself.

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DESCRIPTIONS OF NEW MYMARID EGG PARASITES FROM HAITI AND PUERTO RICO

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Only a few Mymarids have been recorded to date for the West Indies. The present paper describes twelve new species and gives some rearing records from definite hosts.

Altho but one species, *Alaptus borinquensis,* herein included is described from Puerto Rican material, all of them are quite likely to be found in Puerto Rico when the proper rearings can be made. This is especially true of *Anagrus empoascae,* parasitic on *Empoasca fabalis* De Long, the common and injurious leafhopper of beans in Puerto Rico. The determination of *Anagrus flaveolus* Waterhouse, as a parasite of the sugar cane hopper, *Saccharosydne saccharivora* Westw. is of importance since the previous determinations of this parasite as *A. armatus* Ashm. in both Puerto Rico and Haiti are undoubtedly in error.

Due to the extreme difficulty of determining these minute insects except with type material for direct comparison, the types of the new species in this paper are retained for the present in the writer's collection, eventually to be deposited in the U. S. National Museum collection.

Gonatocerus quadrivittatus, new species.

The yellowish color of the female abdomen, marked with four more or less distinct brown cross bands readily differentiates the species.

Female.—Length, including ovipositor, 0.817 mm.; expanse 1.59 mm.; greatest width of forewing 0.237 mm. General color of the head and thorax black, the abdomen dirty yellowish with four more or less distinct cross bands or vittae of brown, the anterior two bands being very narrow and interrupted at the middle; antennae dark brownish-gray, the scape and pedicel of a slightly lighter shade; thorax black marked on disk with two lateral yellowish bands covering a portion of the prescutum around the posterior and lateral margins, and carrying down onto the propodeum. Wings hyaline, the venation brown. Femora pale yellowish, the tibiae, the two distal joints of the tarsi and the first joint of the hind tarsi, brownish-gray.

Head slightly wider than the thorax. Antennae rather long, the scape nearly four times as long as the pedicel and slightly wider; 1st and 2nd funicle joints decidedly shorter than all other joints of the antennae; funicles 3 to 8 subequal in length but each successively increasing in width; club solid, almost equal in length to that of the last three funicle joints combined, about twice as wide as the last funicle joint. Thorax comparatively short and broad, longer than wide. Forewings rather broad, three times as long as greatest width; disk covered with short cilia; marginal cilia very short, the longest on the posterior margin, less than one-sixth as long as the greatest wing width. Abdomen rather slender, over twice as long as wide, the ovipositor short but distinctly exserted.

Male.—Length 0.69–0.817 mm. Differs from the female in coloration of the abdomen, the four brown bands being fused to make the lower two-thirds of abdomen brown in the male. The male varies in length but is generally slightly shorter than the female. The structure of the male antennae is very distinct and different and enables immediate separation from the female; 13-jointed, long and distinctly flattened, all joints except the scape and pedicel have prominent longitudinal sensoria or carinae, the number of these varying, usually from 7–9. The male antennae smoky with the exception of the scape and pedicel which are more yellowish; the funicle joints subequal in length and verying little in width; the first funicle is slightly wider and dilated a little; the last antennal joint is slightly shorter and narrower than the others, narrowing to a tip.

Described from three females and five males, reared by the writer from foliage and stem material of the Barbados Cherry, *Malphigia glabra*, at Port-au-Prince, Haiti, July 30–Aug. 10, 1931. This material was infested with an undescribed aleyrodid and a fulgorid hopper, *Ormenis* sp. A paratype male and female is deposited in the U. S. National Museum collection, No. 43880.

Gonatocerus flaviventris, new species.

Distinguished by its short, compact antennae with very broad club and the yellowish colored abdomen. Closest to *G. cubensis* but smaller.

Female.—Length, including the ovipositor, 0.530 mm.; expanse 1.186 mm.; greatest width of forewing 0.172 mm. General color of the head and thorax dark brown, lighter colored areas on the vertex and thorax; abdomen yellowish, somewhat darker or soiled on the distal third; antennae grayish-brown, the scape and pedicel a shade lighter in color, the scape the palest with the upper margin infuscated; wings hyaline, the venation brown; legs soiled testaceous-yellow, the tibiae and distal two joints of tarsi, brownish.

Antennae comparatively short and compact; the scape short, decidedly compressed, over twice as long as wide; pedicel one-half as long as the scape and slightly narrower; funicles 1–3 very short, subequal in length, about half as long as the pedicel; funicles 4–8 increasing slightly in length and width; club solid, very large, two and a half times as wide as the last funicle, and exactly equal in length to that of the last three funicle joints combined. Forewings not unusually broadened, two and a-half times as long as wide; the disk covered with short cilia; marginal cilia short, those of the posterior margin the longest, about

one-fourth as long as the greatest width of the wing. Abdomen petiolate but the petiole is very short and inconspicuous; the ovipositor barely exserted. Tarsi 5-jointed.

Male unknown.

Described from a single female reared by the writer from Lignum-vitae foliage infested with the Woolly Whitefly, *Aleurothrixus floccosus* (Maskell) at Sarthe, Haiti, March 5, 1931. It is very unlikely, however, that this species is a parasite of the aleyrodid.

Gonatocerus cubensis, new species,

Closest to *G. flaviventris* in coloration but readily distinguished by its lighter colored thorax, more slender antennae, and peculiar appearance of the tarsi.

Female.—Length, including ovipositor 0.602 mm.; expanse 1.31 mm.; greatest width of forewing 0.162 mm. Head dark brown; antennae light brown, the scape and pedicel slightly lighter; thorax a soiled yellowish, the anterior margin of the prescutum heavily infuscated, the entire disk of the thorax clouded with pale brown; the abdomen soiled yellowish, distinctly soiled or clouded on the distal two-thirds; wings hyaline, the venation gray; legs yellowish-testaceous, the hind tibiae slightly darker; all tarsal joints except the basal two of the front legs and the first of the intermediate and hind tarsi, darker, with a peculiar appearance of mixed reddish granular matter and dark setae.

Head about as wide as the thorax. Antennae long and rather slender; the scape slender, two and a-half times as long as the pedicel; pedicel slightly wider than the scape and the first five funicle joints; funicles 1–3 extremely short, only one-half as long as the pedicel. The third very slightly longer than the first two; funicles 4–8 nearly equal in length but widening greatly; club solid, nearly twice as wide as the last funicle and not quite as long as the length of the last three funicle joints combined. Forewings long, widened somewhat spatulate, greatest width only about one-third the length; disk covered with numerous cilia; longest marginal cilia only about one-fifth as long as the greatest width of wing. Ovipositor scarcely exserted. Tarsi 5-jointed.

Described from a single female reared by the writer at Port-au-Prince, Haiti, July 27, 1931, from a shipment of citrus foliage infested with *Aleurocanthus woglumi* Ashby and parasitized with *Eretmocerus serius* Silvestri, received from Dr. C. P. Clausen, collected near Havana, Cuba.

Polynema vittatipennis, new species.

A very large, distinct species with twice-banded wings, closely allied to *P. bifasciatipenne* (Gir.) but is less slender, decidedly smaller, lacks the basal band across the forewing that is present in that species, and the ovipositor appears to be slightly more exserted.

Female.—Length, including ovipositor, 1.348 mm.; expanse 1.95 mm.; greatest width of forewing 0.186 mm. Color of the head, thorax and abdomen dark

brown, the petiole pale yellowish; antennae brown with exception of the yellowish scape and pedicel, the 1st funicle joint a shade lighter than the other funicles and the club. Forewings hyaline, banded near the middle and towards the tip with brown; the apical vitta crosses the forewing at its widest portion and does not quite reach the anterior and posterior wing margins; marginal vein light brown. Legs pale except the femora, distal two-thirds of the hind tibiae, and the last tarsal joints, brown; the front and middle femora have the tips lightened. The extruded ovipositor pale, darkening towards the tip.

Head slightly wider than the thorax. Scape short and stout, subequal in width to the pedicel and a third longer; funicle joints long and narrow, each widening slightly to their distal tips and increasing a little in length; 1st funicle joint narrow, subequal to pedicel in length; 2nd funicle is the longest antennal joint, twice as long as the 1st funicle and a fourth longer than the third; fifth and sixth joints subequal in length and barely longer than the fourth; club solid, very large and wide, nearly four times as wide as the last funicle and slightly longer than the last two combined. Forewings rather narrow, starting slender, enlarge gradually and reach their greatest width shortly before the narrowed but rounded tip; provided with distinct, dark, longitudinally placed, cilia except for the usual naked basal portion, and less numerous middle transparent portion; marginal cilia of moderate length, longest along the posterior margin towards apex; a very narrow clear path follows the base of the marginal cilia around the apex of the forewing. Hind wings extremely narrow, lineate, inconspicuous. Abdomen compressed, narrowed to tip; the sheaths of the ovipositor greatly exserted beyond the abdomen, the ovipositor issuing beneath, originating near the base of the abdomen; the petiole subequal to the hind trochanters in length. Legs long and slender. Tarsi 4-jointed, the proximal joint of the hind tarsi longer than the other joints combined.

Described from two females reared by the writer from sweet potato foliage, infested with several species of leafhoppers, the large Delphacid *Copicerus irroratus* Swz. and several small crickets of the tribe Trigoniniidae from whose eggs the species possibly issued, Port-au-Prince, Haiti, December 30, 1929.

Paratype deposited in the U. S. National Museum collection No. 43877.

The nearest related species, *Polynema bifasciatipenne* (Gir.) was described as a parasite of the eggs of the very small green cricket, *Anazipha exigua.* The U. S. National Museum has numerous specimens from Canada, New York, Kansas, Delaware, and Texas, some of them reared from eggs of the Snowy Tree-Cricket, *Oecanthus niveus.*

Polynema phaseoli, new species.

Very close to *P. eutettixi* Gir and *consobrinus* Gir. in coloration and structure but, after comparison with the types, is separated from those species at once by having both the 3rd and fourth tarsal joints distinctly brown.

Female.—Length, including ovipositor, 0.918 mm.; expanse 1.52 mm.; greatest width of forewing 0.172 mm. General coloration black, the petiole paler; antennal joints all brown except the pedicel which is pale, the anterior marginal portion slightly clouded with fuscous; legs dark brown except the proximal and distal tips of the femora and the first tarsal joints which are yellowish; hind coxae slightly less brown than the others; the 2nd and 3rd tarsal joints grayish, the 4th distinctly black.

Scape short, dilated; pedicel short, subequal in width to the scape at its greatest dilation; first funicle narrow, nearly as long as the pedicel; second funicle decidedly longer than the others, over twice as long as the first; third funicle nearly two-thirds as long as the second; the fourth and fifth subequal in width and length, the sixth distinctly wider and longer; club solid, longer than the last two funicle joints combined. Forewings rather long and slender, slightly narrower than those of *P. haitiana;* hyaline, discal cilia numerous and comparatively short; the longest marginal cilia nearly two-thirds as long as the greatest width of the forewing. Petiole less than one-third as long as the abdomen; abdomen compressed, elongate, the ovipositor distinctly exserted, but short (exserted 3 mm.). Tarsi 4-jointed, the hind tarsi with the proximal joint nearly equal in length to the second and third joints.

Described from two females reared by the writer from red bean foliage at Damien, Haiti, March 3, 1931. The membracid, *Stictocephala sp.,* occurs occasionally on beans in Haiti and its eggs may have been present and the host of this parasite.

Paratype deposited in the U. S. National Museum No. 43878.

Polynema haitiana, new species.

Structurally quite similar to *P. phaseoli* but slightly longer and easily separated by its yellowish-orange legs.

Female.—Length, including ovipositor, 1.06 mm.; expanses 1.84 mm.; greatest width of forewing 0.207 mm. General color black, the petiole and legs yellowish-orange; antennae dark brown except the scape and pedicel which have their dorsal margins slightly infuscated; front tarsi with the proximal joint slightly soiled grayish, the 2nd and 3rd distinctly gray and the last black; the intermediate and hind tarsi with the proximal joint yellowish, the 2nd and 3rd grayish, and the last black.

Head about as wide as the thorax. Scape short, distinctly dilated slightly wider than the large pedicel; first funicle joint short, about two-thirds as long as the pedicel; the second funicle distinctly the longest funicle, two and a-half times as long as the first; third funicle subequal in width to the second but shorter, only two-thirds as long; fourth, fifth, and sixth successively increase in length and width; the club solid, large and prominent, very wide its greatest width being three times that of the last funicle; longitudinal clear sensoria are visible on the last funicle and club. Forewings hyaline, rather slender, the longest marginal cilia only about one-half as long as the greatest width of the wing; the discal cilia numerous, comparatively short. Petiole long, nearly one-fourth the length of the long, rather slender abdomen, the ovipositor distinctly exserted. Tarsi 4-jointed, the first joint nearly as long as the others combined.

Described from a single female taken by the writer while sweeping grass and weeds between coffee and bananas at Fond-des-Negres, Haiti, June 12, 1930.

Anagrus flaveolus Waterhouse.

1913 Bul. Ent. Res., vol. 4, pt 1, May.

A single female reared by the writer from the eggs of the Corn Leafhopper, *Peregrinus maidis* (Ashm.) at Damien, Haiti, Jan. 25, 1930 undoubtedly represents typical *flaveolus*, a species originally described from specimens reared by P. L. Guppy in Trinidad from the eggs of the same host. In the U. S. National Museum are five females reared by P. L. Guppy at St. Joseph, Trinidad, Oct. 17, 1911 from *Peregrinus maidis* eggs and evidently represent a portion of the original rearing that was studied by Waterhouse. These specimens have been carefully studied and have funicle joint 1 distinctly longer than the other funicles and the scape under high magnification shows the dorsal margin distinctly serrated which appears to be very characteristic of this species; numerous minute transverse lines or segmentation is present on the scape.

A series of six males and fourteen females reared by the writer from eggs of *Saccharosydne saccharivora* on sugar cane at Port-au-Prince, Haiti, Aug. 7–9, 1930, were at first determined as *armatus* (Ashm.) but do not agree with North American material of that species, having funicle joint 3 only subequal to 4 and not longer than the fourth as is true of the type of *armatus*. In this series the serrated margin of the scape, so characteristic of all the known *flaveolus* material reared from *Peregrinus maidis*, is only indistinctly present in some of the series. The species of *Anagrus* attacking the eggs of the West Indian Sugar Cane Delphacid may prove to be distinct from *flaveolus* when further material is studied. The body and legs of both sexes of the Haitian material reared from *Saccharosydne saccharivora* eggs were of a distinct orange color with the mesonotum infuscated when living but faded to pale yellowish upon being mounted on slides in balsam.

Anagrus empoascae, new species.

In coloration very like the American *A. armatus* var. *nigriceps* Gir. but most easily separated from that species by its much shorter and stouter antennae with the second funicle joint short, subequal or shorter than the third. In structural characteristics, this species comes closest to *A. epos* Gir. but a large reared series of that species shows it to be distinct and separated at once by *empoascae* having

the distal funicle usually only subequal in length to the second joint and not distinctly longer as is the case with *epos.*

Female.—Length, including ovipositor, 0.387 mm.; expanse 0.875 mm.; greatest width of forewing 0.050 mm. In life the general coloration is distinctly yellowish (not orange in any degree as contrasted with the species of *Anagrus,* reared from eggs of *Saccharosydne saccharivora* and determined as *A. flaveolus* Waterhouse), the head, anterior portion of the prescutum, and the abdomen fuscous; in some specimens only the basal and apical portions of the abdomen are infuscated; antennae gray except the scape, pedicel and first funicle joint which are pale yellowish; legs entirely pale yellowish; when living specimens of this parasite are mounted directly into xylol balsam, the latter is stained yellowish the specimens clearing up distinctly yellowish.

Head subequal in width to thorax. Antennae somewhat similar to *flaveolus* but the funicle joints are rather stout; scape about twice as long as the pedicel, slightly broader than the scape of *A. flaveolus* with the segmentation or transverse lines less distinct and the dorsal border is not serrated as in that species; funicle 1 very short; funicle 2 varying somewhat in length but subequal or slightly shorter than the 3rd and subequal only to the distal joint in length and not decidedly shorter as is the case with *epos* Gir.; all funicles except the first are subequal in length, successively widening. Forewings slightly wider than those of *flaveolus;* the discal ciliation very variable with the number of irregular rows or lines of cilia varying from 4 to 6 partial rows but a more or less distinct naked area is left near the caudal wing margin proximad of the apex which is characteristic of this species. Abdomen at base nearly as wide as the thorax, gradually narrowed to tip, the ovipositor distinctly exserted. Tarsi 4-jointed.

Male unknown.

Described from a series of twenty-nine females mounted in balsam; reared by the writer from eggs of the Bean Leafhopper, *Empoasca fabalis* DeLong, on red bean foliage at Damien, Haiti, Jan. 20–22, 1930; one slide containing four females reared by the writer from bean foliage at Damien, Feb. 26, 1931. Paratype slide containing eight females deposited in the U. S. National Museum No. 43876.

The host of this egg-parasite was described by Dr. DeLong (Canadian Entomologist, vol. 62, p. 92, 1930) and is known from Haiti and Porto Rico. This leafhopper was proved by the work of Smith & Barker in Haiti to be the transmittor of the Bean Yellows disease, the most serious disease of the bean in the West Indies.

Anagrus noeli, new species.

The elongated thorax, arrangement of setae on the sides of the abdomen, short endophragma confined to the thorax, readily differentiates this species.

Male.—Length, exclusive of the oedeagus, 0.516 mm.; expanse 1.03 mm.; greatest width of forewing 0.078 mm. General color dark brown with the lower two-thirds of the prescutum and portion of the axillae, and nearly the basal half

of the abdomen yellowish-orange; oedeagus and antennae pale grayish; hind legs light brown, the front and middle legs distinctly paler.

Antennae 13-jointed, the scape and pedicel subequal in length and width, about half as long as the funicle joints which are all subequal in length and width. Thorax very elongate, slightly longer than the abdomen; prescutum and axillae with a strong seta present; endophragma present but does not extend into the abdomen as is the case with *A. empoascae*. Forewings rather broad for typical *Anagrus*, with prominent fringe of marginal cilia, the longest of which is nearly twice as long as the greatest width of the wing; marginal vein with four setae, the two proximal ones placed very close together; the outer third of the wing is thickly covered with discal cilia; a small but distinct seta is present in the bare area below the marginal vein. The abdomen elongate with the lateral margins running almost parallel for three-fourths the length and then rounding to the tip; oedeagus distinctly exserted and prominent; along each side of the abdomen is a double row of widely separated strong setae, numbering 5–6 setae in the row, the outer row following along the lateral margin. Tarsi 4-jointed.

Described from a single male collected by the writer on leaf of the Sea-grape, *Coccoloba uvifera*, at Port-au-Prince, Haiti, May 26, 1930. The species is named in honor of Mr. Alphonse Noel who rendered the writer valuable assistance in rearing many parasitic hymenoptera as Assistant Entomologist of the Service Technique, Haiti.

Anaphes bicolor, new species.

A very small, distinctly colored species, with flagellum and legs pale.

Female.—Length, including ovipositor 0.416 mm.; expanse 0.89 mm.; greatest width of forewing 0.086 mm. General color dark brown, the basal half of the abdomen yellowish, the distal half black; antennae pale yellowish, except the brown club; legs pale yellowish except the terminal joint of the tarsi. Head short and deep. Scape rather short and compressed, only twice as long as the wide pedicel; first funicle joint very short and narrow, the second slightly longer, subequal in width; third funicle conspicuously the longest and widest joint of the funicle, about twice as long as the second; funicles 4–6 very short, about equal in length to the second but distinctly swollen, the fifth and sixth appearing somewhat globose; club appearing under high magnification almost as if having a division, almost as long as the last four funicle joints combined, distinctly wider than the other joints. Thorax longer than the abdomen. Forewings nearly four times as long as the greatest width; distal two-thirds of forewings covered with numerous short cilia; longest marginal cilia are along the outer posterior margin, equal in length to the greatest width of the blade. Femora wide and distinctly flattened. Abdomen slender, ovipositor distinctly exserted. Tarsi 5-jointed.

Described from two females mounted in balsam on two slides; reared by the writer from red bean foliage infested with the Bean Leafhopper, *Empoasca fabalis* DeLong, at Damien, Haiti, Jan. 21–22, 1930.

Camptoptera minutissima, new species.

This is the smallest known member of the genus. Distinguished by its minute size and extremely short pale first funicle joint.

Female.—Length 0.215 mm. General color light grayish-brown, the basal third of the abdomen distinctly paler. Antennae uniformly pale gray, the pedicel only slightly lighter in shade. Eyes black. Ocelli reddish. Wings hyaline or barely perceptibly smoky. Legs pale yellowish.

Vertexal carina present. Thorax distinctly wider than the abdomen and about one and a-half times as long. Under high magnification, the vertex and prescutum appear horizontally or cross-wise finely lineate, the scutellum longitudinally lineate; petiole short, not barbed as in *C. pulla* Gir., the thorax on its hind margin is produced into two short barb-like projections at the middle on each side of the petiole; abdomen broad at its base, narrowing on each side somewhat triangular shaped to point formed by the barely exserted ovipositor. Antennae elbowed, long and slender, almost as long as the body, nine-jointed with an additional very minute ring-joint following the first funicle; scape rather short, only slightly longer than the pedicel; pedicel very large and wide; first funicle extremely short in comparison with other known species of the genus, about one-fourth as long as the pedicel and only one-fifth as long as the second true funicle joint; a very minute but clearly distinct ring-joint is visible under high magnification between the first and second true funicle joints; third funicle nearly a third shorter than the second; fourth, fifth and sixth subequal in length but increasing slightly in width; club solid, long, subcylindrical ovate, slightly longer than the last three funicle joints combined; the funicle and club joints are provided with numerous minute setae; the club, in the single specimen, appears to have a distinct longitudinal crease or fold. Forewings typical of the genus, longer than the body, slender, with a distinct dilation along the caudal margin at proximal fourth, curved or bowed at the apical half; with complete fringe of long cilia, the usual clear path around the margins of the wing; a double longitudinal row of minute setae follow around the margins of the wing and on the disk near the apex are two distinct setae; anterior margin of the wing is slightly darker and more distinctly outlined; hind wings linear, slightly curved at about the middle. Legs normal, with five subequal tarsal joints.

Described from a single female, reared by the writer from avocado foliage infested with *Empoasca minuenda* Ball at Petionville, Haiti, Dec. 16, 1930.

Alaptus minutus, new species.

This is the second smallest recorded North American species for the genus *Alaptus*, measuring only 0.215 mm. The smallest *globosicornis* Gir. measures only 0.199 in the female sex. In male antennal characters this species is closest to *eriococci* Gir. but differs greatly in both coloration and size.

Male.—Length 0.215 mm.; expanse 0.588 mm.; greatest width of forewing 0.022 mm. Very minute. General color of head and abdomen pale brown, the thorax especially across the middle distinctly paler; ocelli red; antennae with

whitish scape and pedicel, the funicle joints 1–3 pale brown, 4–8 distinctly brownish; the legs pale.

Antennae 10-jointed, long and slender, the scape narrowest at base, somewhat compressed, one and a-half times as long as the pedicel; pedicel subconic, wider than the scape; first funicle joint the shortest, funicles 2 and 3 subequal but only about two-thirds as long as the remaining joints which are subequal in length and increasing perceptibly in width; the scape with three setae along the lower margin and one near the upper margin; the pedicel with three setae. Vertexal carina present. Eyes naked or without hairs. Thorax without setae except for an extremely long one on the axilla; prescutum under high magnification appearing minutetly and transversely rugulose or lineate; endophragma present extending back one-half the length of the abdomen. Wings normal for the genus, long and narrow with the remarkable dilatation near the base of the forewings, terminating in a conspicuous excised notch; the remainder of the wing with fringe of long cilia; a median line of discal cilia present, the number of cilia evidently variable, one wing showing seven and the other ten.

Female unknown.

Described from a single male specimen reared by the writer from lime foliage, infested with *Parlatoria zizyphus* scale, etc., at Port-au-Prince, Haiti, June 18, 1931. Most probably from the eggs of a psocid as the other definitely known hosts of members of this genus are for the most part parasites of psocid eggs.

Alaptus borinquensis, new species.

A very variable species in size.

Female.—Length, including ovipositor 0.186–0.344 mm.; expanse 0.745 mm.; greatest width of forewing 0.029 mm. General color dark brown, the antennae and legs light brown, the pedicel slightly paler.

Antennae 8-jointed, the scape and pedicel very stout and compressed, the latter a third shorter than the scape and slightly wider; first two funicles very narrow, only one-third as wide as the pedicel, the second about one-third longer than the first; the remaining funicles successively enlarging, 3 and 4 subequal in length, 5 somewhat shorter; club solid, very large, nearly twice as wide as the last three funicle joints combined. Prescutum under high magnification with somewhat obliquely arranged lineations, provided on each side with a strong seta; axilla with a short seta. Forewings shaped somewhat as in members of the genus *Dicopus* with a very prominent wide transparent path around the base of the marginal cilia; from 13–15 discal cilia present, characteristically placed in this species in a line just inside the anterior margin of the forewing, following the contour. Endophragma present. Abdomen slightly longer than the thorax, the ovipositor prominent and distinctly exserted.

Male. Length 0.243 mm. Similar to the female except the 10-jointed, filiform antennae; the coloration of the legs and antennae appear paler. Scape and pedicel stout, about same as those of the female; the funicle joints 1–3 very narrow, the first being about a third shorter; funicles 4–7 subequal in length and width, distinctly wider than the other funicles; the special joint or

club is a third shorter than the preceding joint, distinctly narrower, narrowed to somewhat pointed tip.

Described from four females and two males reared by the writer from *Asterolecanium pustulans* scale material on *Cassia fistula* at Rio Piedras, Porto Rico, May 14–19, 1925. A paratype female is deposited in the U. S. National Museum collection No. 43879.

NOTES ON THE GENUS *ANERISTUS* HOWARD WITH DESCRIPTIONS OF NEW SPECIES
(*Hymenoptera: Chalcidoidea*)

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The purpose of this paper is to establish as clearly as possible the status of the genus *Aneristus* Howard, to assemble all the available information concerning the habits and host-relationships of its members, and to make known three new species from the West Indies. So far as known all the species of *Aneristus* are primary parasites of the non-diaspine Coccidae or soft scale insects and are of great economic importance.

Aneristus ceroplastae How. is one of the most important enemies of soft scales in the West Indies and is widely distributed throughout the tropics. It does not confine its attack to any one species but is recorded as having been reared from at least six different genera. *Aneristus youngi* Girault has been reared from two different genera in Louisiana. *A. mangiferae* Dozier and *asterolecanii* Dozier appear to confine their attack principally to the Mango Soft Scale, *Coccus mangiferae* (Green), and the Golden Asterolecanium, *A. aureum* Boisd., respectively, and are known only from the West Indies.

Compere in his recent "Revision of the species of Coccophagus"[1] points out that the genus *Coccophagus* is imperfectly defined and that the characters used to separate this from *Aneristus, Prospaltella* and certain other allied genera are relative and cannot be sharply defined. The few species of *Aneristus* described to date have been distinguished from those of *Coccophagus* by having a row of short stiff bristles behind on the flattened posterior tibiae, and a distinctly compressed funicle. In true *Coccophagus* the hind tibia is normal with the row of distinct bristles lacking, and the flagellum is fusiformly subcylindrical, the funicle joints usually plainly longer than wide. In addition all recorded species of *Aneristus* where both sexes are known, have the forewing of the female hyaline with a distinct infumation on the discal portion while the male forewing is entirely hyaline.

In 1915 Silvestri erected the genus *Prococcophagus*, based on the

[1] Proc. U. S. National Museum, vol. 78, art. 7, pp. 1–132, pls. 1–14, 1930.

female sex of the new species, *Prococcophagus varius* Silv.[2], stating that the new genus could be separated from *Coccophagus* by the differences in the head, dorsum, greater length, by having the antennae inserted a short distance from the clypeal margin, and by the large compressed scape. The two new species described in this paper as *A. hispaniolae* and *asterolecanii* clearly fall into *Prococcophagus* but grade into *Aneristus* if the concept of that genus be broadened to include those species with the scape much flattened or foliaceous. In the writer's opinion *Prococcophagus* must fall as a synonym of *Aneristus* which, however, seems sufficiently distinct from *Coccophagus* to be retained. The last-mentioned genus seems very closely connected to *Aneristus* by such species as *Coccophagus modestus* Silv., *bivittatus* Compere, and *argenteus* Gir. Compere states that the last species has unusual wings, unlike any other described *Coccophagus*.

Girault in 1917 (Ins. Insc. Menstruus, vol. 5, p. 37) synonymized his genus *Tanaeostigmoidella* with *Prococcophagus* Silv.

The following characterization of the genus *Aneristus* has been broadened to include those species with the scape dilated or foliaceous. In certain species such as *A. ceroplastae, croconotus, mangiferae,* and *oculatipennis* a conspicuous group of strong setae are present at the proximal end of the middle tibia; in others such as *hispaniolae* and *asterolecanii* these are lacking. A minute study of the chaetotaxy of all the species should be made when further material of certain species becomes available.

The genus *Aneristus* Howard

Aneristus Howard, The Canadian Entomologist, vol. 27, 1895.

Characterization.—Closest to *Coccophagus*. Antennae eight-joint, with a very minute ring-joint, barely discernible under high magnification, present in the female sex between the pedicel and first funicle joint; the scape is distinctly compressed and in certain species is more or less foliaceous; a longitudinal carina is usually present on the scape, dividing the inner portion which regularly forms the scape from an outer more foliaceous extension; the club well-defined, distinctly three-jointed; very characteristic longitudinal elevations or sensoria are present on the club and the funicle joints, although sometimes lacking on the first funicle; these sensoria are particularly prominent in the male. Eyes setose. Forewings with the marginal vein longer than the submarginal, a fuscous cloud generally present with the female but lacking in the male. Hind tibiae flat, with a row of short, stiff bristles behind; the hind femora somewhat thickened; middle tibial spur long and slender, almost as long as the first tarsal joint; all tarsi five-jointed. Internal parasites of the Soft or non-diaspine Coccidae.

Genotype.—*Aneristus ceroplastae* Howard.

[2] Descrizione di nuove Imenotteri Chalcididi africani, Bol. Lab. Zool. Portici, vol. IX, pp. 359–360, 1915.

Key to females of *Aneristus*.

1. Scape distinctly widened or foliaceous ---------------------------------- 6
   Scape not unusually widened -- 2
2. Dominant color dark, submetallic, the prescutum concolorous --------------- 8
   Dominant color lighter, the prescutum marked with yellow ------------------ 3
3. Prescutum with lemon-yellow blotch; forewings with large infumed area extending completely across the wing. Africa ---------- *croconotus* Waterston
   Prescutum with a wide yellowish band across the middle; forewing with a very narrow infumed area, not reaching across the wing. Haiti, Santo Domingo and Cuba ---------------------------------- *mangiferae* new species
   Prescutum with a yellowish-white band; forewing with a three-fourths complete circular infumed ring. Peru and Panama -------- *oculatipennis* Girault
6. Third funicle joint brown, the upper third white. Haiti -- *asterolecanii* new species
   Third funicle joint entirely whitish -- 7
7. Forewings with a wide hairless or bare area running longitudinally along the lower margin from the base to one-half the length of the forewing. Haiti -- *hispaniolae* new species
   Forewings without this hairless area. Africa ---------------- *varius* Silvestri
8. Black without distinct purplish reflections, the coxae pale; head more or less and the scape yellowish. Louisiana ------------------------ *youngi* Girault
   Black, with purplish reflections, scape pale, the head and coxae black. Widely distributed in the tropics ------------------------------ *ceroplastae* Howard
   Wholly dark metallic purple, the legs and antennae dark except most of the first tibiae, distal half of the middle tibiae, and the tarsi, which are yellowish-white; proximal half of the middle tibiae black; forewings with a large infumed area, its proximal margin obliquely truncate from about the proximal third or more of the marginal vein. Australia -- *fumosipennis* Girault & Dodd
   Wholly dark metallic purple, the legs and antennae dark except the scape and cephalic knees and tibiae which are white and all middle tibiae except slightly just distad of the knee; infumed spot on forewings shorter, its proximal margin straight. Australia -------------------- *diabolicus* Girault

The writer has not seen specimens of *A. croconotus* Waterston, *fumosipennis* Girault & Dodd, *varius* Silvestri, and *diabolicus* Girault and these species are included in the above key based on characters included in the original descriptions. To date the males of only three species are known, namely, *ceroplastae* Howard, *croconotus* Waterston, and *asterolecanii* Dozier.

Aneristus mangiferae, new species.

Closest in coloration to *A. croconotus* Waterston but has the infumed area of the forewings decidedly narrower than in that species.

Female. Length 1.02 mm.; expanse 1.72 mm.; greatest width of forewing 0.301 mm. General color of head and thorax yellowish-orange, the pronotum, scutellum, axillae, lower part of the scapulae, and the abdomen submetallic dark brown to black; a prominent yellowish band runs across the prescutum and upper portion of the scapulae, the anterior and posterior margins of the prescutum narrowly fuscous. Eyes dark. Ocelli red. Antennae with the scape pale yellowish,

the pedicel darker, and marked on upper margin with fuscous; the funicle and club joints smoky. Legs dirty yellowish to slightly smoky, except the slightly paler tarsi, and the dark brown hind femora and tibiae; the terminal tarsal joints smoky. Forewings with the venation smoky, hyaline; a rather narrow smoky infumation runs downward on the disk extending two-thirds across the width of the wing; this cloud starts on its outer margin at the stigmal vein, soon broadening out on the disk; from the stigmal this cloud extends inward to nearly half the length of the marginal vein.

The antennal scape rather long, compressed but not unusually widened, the pedicel subtriangular; minute ring-joint present; the funicle and club distinctly compressed, with prominent longitudinal sensoria; the first funicle joint is the longest, twice as long as the pedicel and about a third longer than the second and third subequal funicle joints; the joints nearly subequal in width or only slightly widening to including the first club joint; the lateral margins of each joint somewhat rounded at the ends; this last condition is accentuated in the club joints, the last two being narrower successively to tip; the shape of the

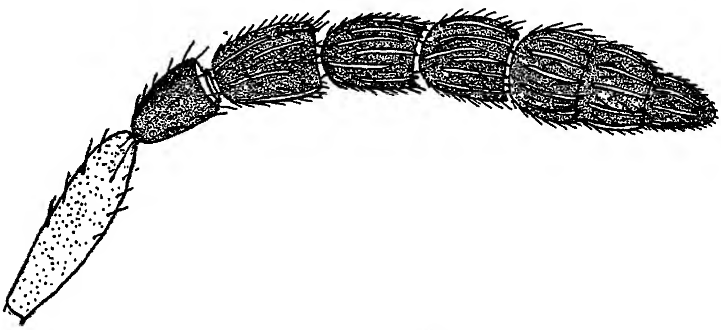


Figure 1.—Antenna of female *Ancristus Mangiferae*, new species, greatly enlarged.

club is rather distinctive in this species; all joints distinctly setose. The vertex, prescutum and scutellum are provided with numerous setae; axillae with a pair of setae; scutellum with a middle pair of small pores, a very strong pair of setae close to the posterior margin and a smaller pair placed anteriorly to these. The dark portions of the head, body and legs minutely reticulated in balsam-mounted specimens under high magnification. The middle femora supplied with a single prominent black seta near distal end, the middle tibia with a conspicuous group of five black setae at the proximal tip. Ovipositor barely exserted, visible in clear, balsam-mounted specimens, extending back to including the third tergite.

Male unknown.

Described from seven females mounted in balsam on slides, reared by the writer from *Coccus mangiferae* (Green) on mango foliage at Petionville, Haiti, Nov. 19–30, 1930; one female reared by Dr. Giuseppe Russo from *Saissetia hemisphaerica* (Targ.) at Moca, Republica Dominicana, March 9, 1928; and a single female reared by the writer in Haiti from Citrus material received from Cuba, during the course of *Eretmocerus serius* releases.

The type female from Haiti is deposited in the U. S. National Museum, Type No. 43807, together with the paratype females from the Dominican Republic and Cuba.

Aneristus ceroplastae Howard.

1895. Canadian Entomologist, vol. 27, p. 350.

1895. Proc. U. S. Nat. Museum, vol. 18, p. 633, *Coccophagus orientalis* How.

The original description was based only on the female sex, the male being described by the writer in 1927 (Jr. Dept. of Agr. of Porto Rico, vol. IX, no. 4, p. 366, 1925). At that time many rearing records from various hosts were given. In addition the writer has reared the species in Haiti in numbers from *Saissetia hemisphaerica* on weeds in coffee glade at Fond-des-Negres, March 3, 1930; from *Coccus mangifera* on mango at Petionville, Dec. 1, 1930; from *Coccus viridis on* "Cerisier marron", *Adelia ricinella*, at Petionville, Nov. 8, 1929; from *Ceroplastes dozieri* Cockl. on *Maytenus buxifolia* at Source Puante, Nov. 19, 1929; and from *Icerya* sp. on a wild bush known as "Ti buis" on Morne-a-Cabrits, Sept. 10, 1930.

Aneristus oculatipennis Girault.

1916. Psyche, vol. 23, p. 42.

The type and paratype card-pointed material from Peru in the U. S. National Museum has been studied together with the original slide containing head and wing, mounted in balsam. Two specimens reared by J. Zetek at Ancon, Canal Zone, Panama (Z 2594) in the U. S. National Museum, determined by Mr. A. B. Gahan, agree well with the type and extend the known distribution of the species.

Aneristus youngi Girault.

1917. Descr. Hym. Chalc. Var. cum Observ. V, p. 11.

The very brief description of this species appeared in a privately published paper. and is given here to make it readily accessible.

"*Aneristus youngi.* Like *Coccophagus modestus* Silv. but legs black save hind coxae and first tibia, all tarsi; head more or less and scape yellow; scutellum hairy. From *Ceroplastes chrysanthemum* Baton Rouge, La., September, E. S. Tucker. Cat. No. 21477."

The type material, consisting of three card-pointed specimens, has been examined. These were reared from *Ceroplastes* sp. on chrysanthemum, evidently from either *C. cirripediformis* or *floridensis*, the only two species of *Ceroplastes* recorded from Louisiana. A specimen, reared by the writer from *Saissetia hemisphaerica* at New Orleans, La., Sept. 16, 1922 (Q-21511) and a specimen from *Coccus hesperi-*

dum on citrus at New Orleans, Jan. 15, 1926 agree exactly with the type. The last-mentioned specimen is mounted in balsam on a slide and a photomicrograph of its forewing is shown. The record of *A. ceroplastae* from Louisiana given by the writer in his paper on "An Outbreak of the Red-striped Sugar-Cane Scale" (Jour. Dept. Agr. of Porto Rico, vol IX, no. 4) was based on this specimen and is erroneous. *Aneristus youngi* Gir. can easily be distinguished from *ceroplastae* How. by its black color, lacking the distinct metallic purplish reflections of that species, by the pale coxae, by having the middle tibiae fuscous, and the infumed area of the forewing is distinctly narrower.

Aneristus hispaniolae, new species.

A large, well-marked and distinct species, easily recognized by its peculiar coloration and very foliaceous scape. In width of scape this species is closest to *Aneristus varius* Silv.

Female. Length .946 mm.; expanse 1.56 mm.; greatest width of forewing 0.237 mm. General color of the head and thorax orange, the ground color of

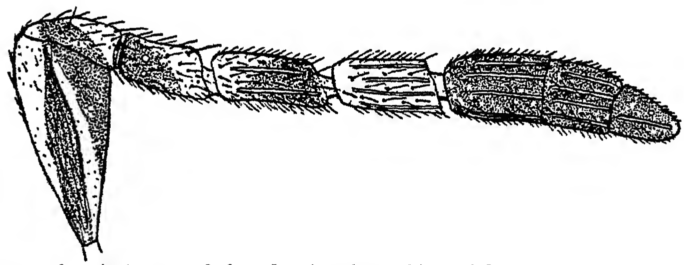


Figure 2.—Antenna of female *Aneristus hispaniolae*, new species, greatly enlarged.

the abdomen a pale yellowish-white with a broken band of black on each segment, leaving a pale colored median longitudinal area running from the dark brown endophragma to just before a line parallel with the vibrissal plates; under high magnification, the black areas appear more or less distinctly reticulated; legs pale testaceous, the proximal tips of the middle and hind tibiae and the terminal tarsal joints are very faintly marked with fuscous, scarcely noticeable. Ground color of antennae pale with the club brown; on the scape is a longitudinal stripe of brown along the middle and the outer widened part is distinctly infuscated; basal two-thirds of the first funicle joint and the lower half of the second are irregularly and somewhat obliquely infuscated. Eyes black.

Antennae eight-jointed, long. ventrally articulated, composed of scape, pedicel, a very minute ring-joint, three funicle joints and three-jointed club; the scape characteristically greatly widened or foliaceous, the inner part elongately reticulated; pedicel somewhat triangular, the funicle joints cut off obliquely on their inner half; all joints furnished with prominent setae; those joints forming

the club and the distal two funicle ones have longitudinal elevations or sensoria; the first funicle joint lacks these but is supplied near its base with two or three pale blister-like circular areas. Eyes setose. The head, thorax, and sides of the abdomen have numerous prominent dark setae. Forewings with a very short marginal fringe of cilia; the setae are very prominent and heavy, contrasting with a wide area running longitudinally along the lower margin from the base to one-half the length of the forewing and a wide area following the apical part of the wing, which appear to be bare or hairless areas on account of the transparent setae. Femora of middle legs with a long seta on posterior margin near the tip; all tarsi five-jointed. The brown ovipositor slightly exserted, visible for its entire length in balsam-mounted specimen, extending to the middle of the fourth tergite.

Male unknown.

Described from a single female, mounted in balsam on slide, reared by the writer from a giant wax scale, *Ceroplastes giganteus* Dozier, on branches of wild fig tree, *Ficus rubricosta* Warb. at Source Cazeau, Haiti, April 16, 1930.

The type slide is deposited in the U. S. National Museum, No. 43808.

Aneristus asterolecanii, new species.

Very closely related to *A. hispaniolae* Dozier, but the female is easily separated by its smaller size, less widened scape, and difference in coloration of the antennae.

Female. Length 0.803 mm.; expanse 1.28 mm.; greatest width of forewing 0.201 mm. General color a pale yellowish-white, marked with brown. The pronotum, disk of the axillae, and the lower margin of the scutellum, dark brown; the remainder of the thorax except the pale discal portions of the prescutum and scutellum, of a reddish-orange color; endophragma dark brown; under direct light, the pale portions of the prescutum, scapulae, scutellum, and the endophragma appear to reflect distinctly iridescent hyaline. Antennal ground color pale, the lower or posterior two-thirds of the pedicel, and of the three funicle joints brown; the club brown except the extreme tip which is pale; the scape pale except a comparatively narrow longitudinal brown strip along the middle. The eyes reflect hyaline. Abdomen of a pale yellowish-white ground color, the posterior half of each segment transversely banded with brown, the anterior one only partial, widely interrupted at the middle. Legs pale, the middle tibiae with two inconspicuous brown spots. The darkened areas of the body and the scape appear under high magnification more or less distinctly reticulated.

Antennae with the scape distinctly foliaceous, being intermediate in width between *A. hispaniolae* and *A. magniferae;* the pedicel slightly longer than wide, subtriangular; the first funicle joint slightly longer than the pedicel and about two-thirds the length of the second funicle, with two or three small blister-like inconspicuous areas present; third funicle slightly longer than the second and almost the same in width; club three-jointed, each joint successively shorter and narrowing to the blunt tip; prominent longitudinal sensoria present on the second and third funicle joints; a very minute ring-joint is present between the pedicel and the first funicle joint. The antennal joints are ventrally articulated. Eyes prominent, distinctly setose. The vertex, prescutum, and lower portion of the abdomen provided with numerous conspicuous setae; three setae are present on the axillae, the inner seta twice as long as the others; scutellum with posterior pair of setae decidedly stronger than the anterior pair and placed much farther apart; the propodeum with a pair of very long, prominent setae. Forewings very faintly infumed at the middle covering over half the wing area; the tip with hyaline area which extends along the posterior margin from the base outwards to a point nearly half the length of the marginal vein. Hind femora and tibiae compressed, the middle femora supplied with a prominent long seta on the posterior margin towards the tip. The ovipositor only very slightly exserted, extending to the fourth tergite.

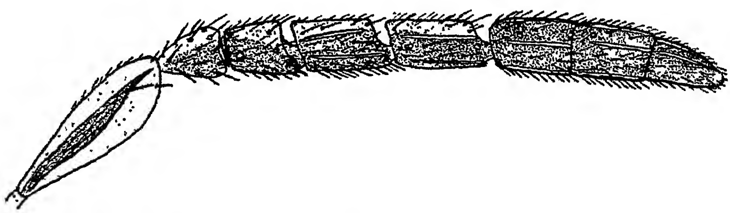


Figure 3.—Antenna of female *Aneristus asterolecanii*, new species, greatly enlarged

Male. Length 0.574–0.602 mm.; expanse 1.075–1.176 mm.; greatest width of forewing 0.172–0.186 mm. Resembles a *Coccophagus*. Varies considerably in size. Differs in coloration from that of the female, the vertex and thorax a dark yellowish-orange, the axillae dark. Antennae smoky brown, the basal third of the scape lightened. The propodeum and abdomen distinctly smoky brown. Legs pale, the hind tibiae slightly smoky. Forewings hyaline, lacking the infumation of the female.

Antennae distinctly flattened, ventrally articulated; the scape differing greatly from that of the female, being long and rather slender, only slightly compressed, longer than the pedicel and first funicle joint combined, the longitudinal recticulations faint; the longitudinal carina of the female scape is very indefinite or partial in the male; the minute ring-joint of the female antenna is lacking in the male; the first funicle joint distinctly longer and wider than the pedicel, and only perceptibly shorter than the second and third funicle joints; all joints narrowing successively to the tip of the club; the first club joint the longest; all funicle and club joints provided with prominent setae, and very distinct longitudinal sensoria. The entire area of the forewings are covered with distinct setae, the bare area of the female forewings being lacking.

Described from two females and seven males, mounted in balsam on slides, reared by the writer from *Asterolecanium aureum* (Boisd.) on wild *Annona* sp. on Morne-a-Cabrits, Haiti, May 22–June 1, 1931.

The holotype female and allotype male are deposited in the U. S. National Museum, No. 43809.

In addition to the above-discussed members of the genus *Aneristus,* the following species have been described to date from various parts of the world:

Aneristus varius (Silvestri)
1915 Boll. Lab. Zool. Portici, vol. 9, p. 359, *Prococcophagus.*
Aneristus diabolicus Girault
1915 Mem. Queensland Museum, vol. 4, p. 65
Aneristus fumosipennis Girault & Dodd
1915 Mem. Queensland Museum, vol. 4, p. 64
Aneristus croconotus Waterston
1917 Bul. Ent. Research, vol. 7, pt 3, p. 234

Table of recorded species of *Aneristus* and their known hosts.

Name of the species	Known distribution	Hosts
Aneristus ceroplastae Howard	West Indies, Ceylon, Java and Hawaii	*Saissetia hemisphaerica* (Targ), *Coccus mangiferae* (Green), *Ceroplastes actiniformis* Green, *C. dozieri* Cockerell, *Pulvinaria iceryi* Guerin, *Coccus viridis* (Green), *Eucalymnatus tesselatus* (Signoret), *Saissetia nigra* (Nietn.), *Icerya* sp.
Aneristus asterolecanii Dozier	Haiti	*Asterolecanium aureum* Boisduval.
Aneristus youngi Girault	Louisiana	*Ceroplastes* sp., *Saissetia hemisphaerica* (Targ.), *Coccus hesperidum* Linn.
Aneristus hispaniolae Dozier	Haiti	*Ceroplastes giganteus* Dozier
Aneristus oculatipennis Girault	Peru and Panama	*Saissetia oleae* (Bernard).
Aneristus varius (Silvestri)	Eritrea, Africa	Unknown.
Aneristus croconotus Waterston	Gold Coast, Africa	*Lecanium* sp.
Aneristus mangiferae Dozier	Haiti, Santo Domingo, Cuba	*Coccus mangiferae* (Green), *Saissetia hemisphaerica* (Targ.)
Aneristus diabolicus Girault	Australia	Unknown.
Aneristus fumosipennis Girault & Dood	Australia	Unknown.

Explanation of Plates

The photomicrographs used in Plates I and II were secured from the U. S. Bureau of Entomology and are the work of the Bureau

photographer, Mr. J. G. Pratt, and the writer wishes to herewith express his appreciation.

PLATE XI

Forewing of female *Aneristus oculatipennis* Girault, paratype wing, U. S. National Museum Type No. 19211.

Forewing of female *Aneristus youngi* Girault, female reared from *Coccus hesperidum*, New Orleans, La.

Forewing of female *Aneristus ceroplastae* Howard, from paratype of *Coccophagus orientalis* Howard, U. S. National Museum Type No. 6905.

PLATE XII

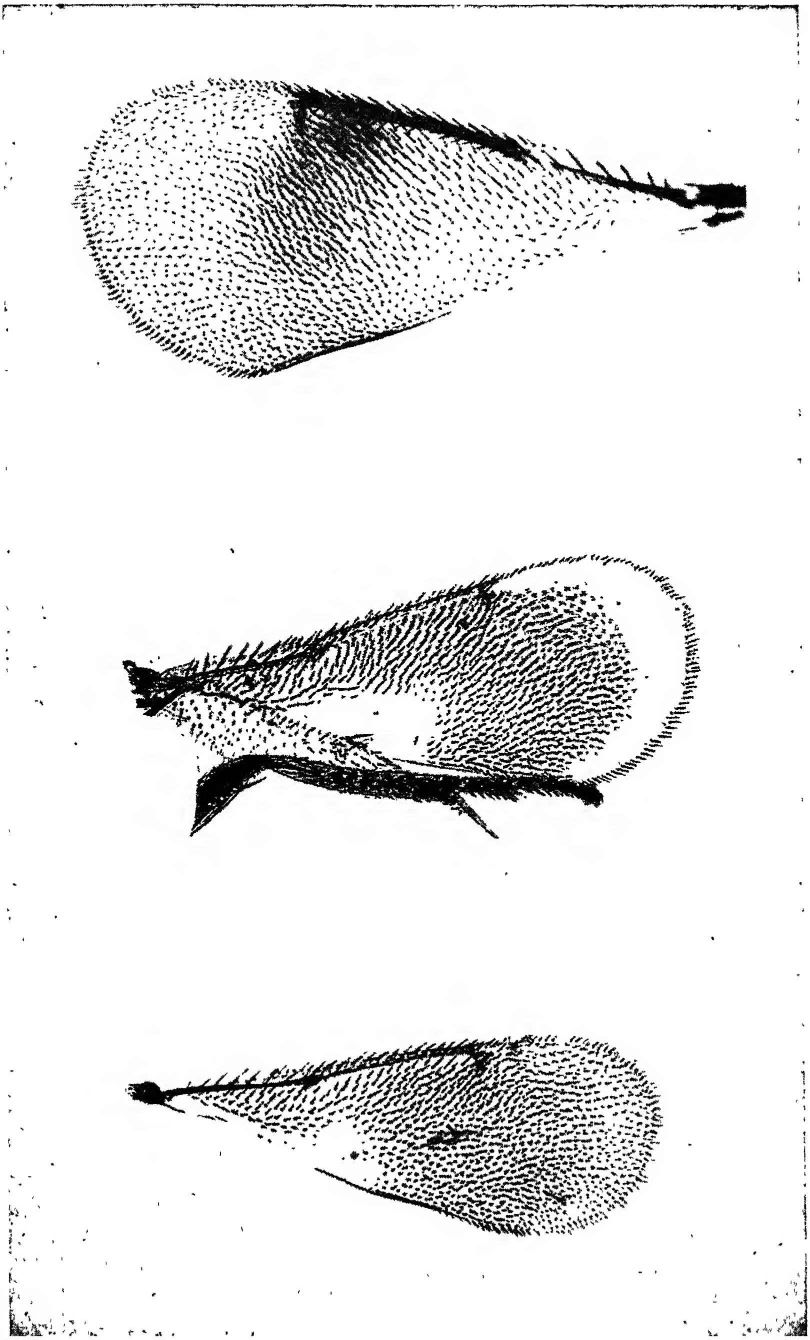
Forewing of female *Aneristus mangiferae* Dozier, paratype female, U. S. National Museum Type No. 43807.

Forewing of female *Aneristus hispaniolae* Dozier, type female, U. S. National Museum Type No. 43808.

Forewing of female *Aneristus asterolecanii* Dozier, paratype female, U. S. National Museum Type No. 43809.

PLATE XI

PLATE XII



TWO IMPORTANT WEST INDIAN SEED-INFESTING CHALCID WASPS

By Herbert L. Dozier
Formerly Chief Entomologist, Insular Experiment Station, Río Piedras, P. R.

The following brief and incomplete notes are presented here in order to call attention to two seed-infesting chalcid wasps in the hope that they will be studied further by other workers as the opportunity occurs. Both are of much economic importance but the damage occasioned by them has heretofore been completely overlooked. Although our knowledge of the distribution of these species is extremely limited, they undoubtedly will prove to be present on most of the islands of the West Indies and, possibly, wherever their host plants occur.

The writer wishes to express his thanks to Mr. A. B. Gahan of the U. S. National Museum for his kind assistance in placing these species generically.

THE LOGWOOD OR CAMPECHE SEED CHALCID

In 1890, Dr. L. O. Howard erected the genus *Tanaostigma* to include a single species, *T. coursetiae* Howard, from the ovaries of a rare leguminous tree, *Coursetia ? mexicana* Watson, in Mexico. In commenting on this unusual and supposedly phytophagous *encyrtid* he states that "We must leave it for future field observations upon this or upon some congeneric species to definitely settle this most interesting point". It is therefore exceedingly interesting to present, after a lapse of 42 years, a second species of the genus with conclusive proof of its phytophagous habits.

Dr. Giuseppe Russo has rather recently (Bol. Lab. Zool. Portici, vol. xxiv, pp. 132–139, 1930) described the new genus *Cubaniella* based on the single species *Cubaniella trotteri* Russo, from galls of *Belaira mucronata* Gris, collected at Santiago de las Vegas, Cuba, by Dr. S. C. Gruner. He places his genus in the subfamily Perilampinae Howard. His material represents a genus undoubtedly very close to *Tanaostigma* Howard, placed by Dr. Ashmead in a distinct tribe Tanaostigmini of the subfamily Eupelminae. Members of this tribe show certain relationships with both the Perilampinae and the Eurytominae as well as with the Eupelminae and it is a mooted question as to where they properly belong. The description of the Cuban

species, unfortunately, is based only on the female but is sufficient to show its close relationship with the new species from the seeds of logwood.

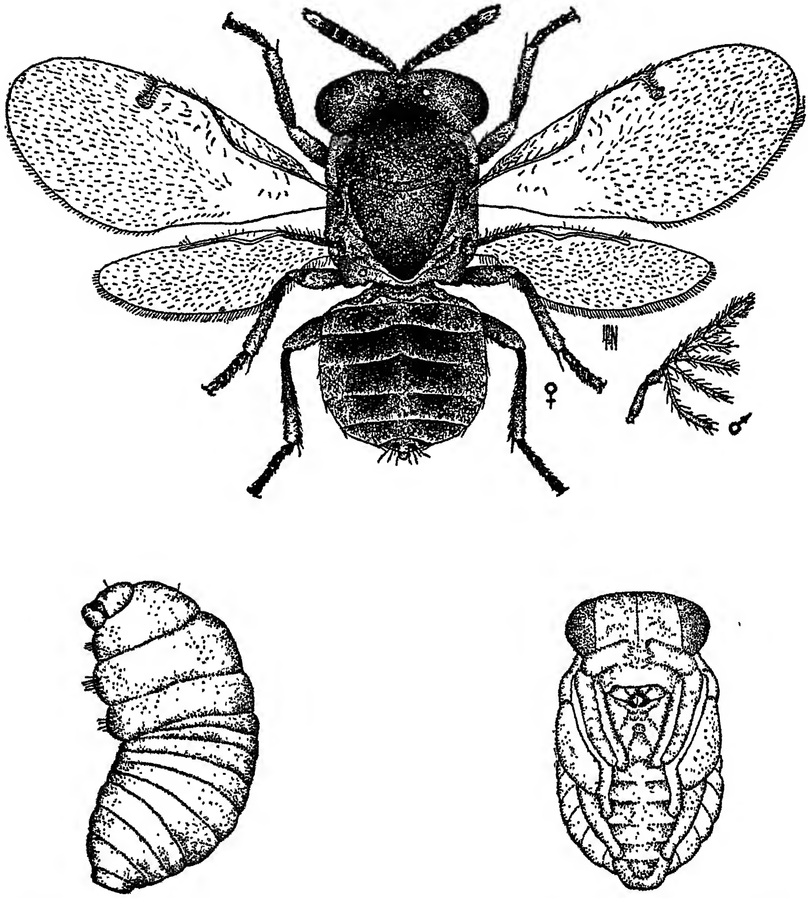


Fig. 1.—Adult female of the logwood seed chalcid, *Tanaostigma haematoxyli* Dozier, male antenna, full-grown larva and pupa, all greatly enlarge (original)

TECHNICAL DESCRIPTION

Tanaostigma haematoxyli, new species.

This species appears to be much stouter than *T. coursetiae* Howard and differs from that species distinctly by its different coloration and

by having the female scape less flattened. Both sexes of this species show considerable variation in size but the male is usually decidedly smaller. The variation in size of individuals is due most probably to different moisture conditions and food available in different seed pods.

Female. Length 1.21–1.46 mm.; expansion 2.84 mm.; greatest width of forewing 0.573 mm. The general appearance of the female is stout and compact, the thorax decidedly humped or convexly elevated; slightly pubescent with light colored hairs. General color a dark honey-yellow, the vertex and more dorsal portions of the thorax and abdomen more or less infuscated giving a fuscous appearance except along the sides; the sides of the abdomen are pale in color. Antennae dark brown except the pale ring-joint and the white club; 11-jointed; club apparently solid; pedicel nearly twice as long as wide, followed by a small ring-joint and a second larger and darker joint that borders on being a true ring-joint, decidedly smaller and narrower than the funicle joints which are subequal in length and only slightly widening to the club. Head transverse. Pronotum narrower than the head and slightly longer, the scutellum convexly elevated, with reticulate markings or areas on surface. Forewings hyaline, venation pale brown, the stigmal vein very thick, covered with numerous curved setae. Under high magnification, specimens mounted in balsam, show the thorax and abdomen to be distinctly reticulated. Legs brown, the hind tibiae armed with pale rigid bristles along the inner margin.

Male. Length 0.86–1.37 mm.; expansion 2.65 mm.; greatest width of forewing 0.502 mm. Easily distinguished from the female by its smaller size, narrower and more slender build, lighter coloration, and immediately by its branched antennae. General color similar somewhat to that of the female but lighter yellowish. Antennae 13-jointed, composed of a rather broad scape, short stout pedicel, a pair of minute ring-joints, theh next five funicle joints increasing in length, each one with a lateral prolongation, successively shorter, giving a branched appearance; the last funicle joint is slightly shorter than the two preceding and has only a suggestion of a short lateral prolongation.

Described from a large series of both sexes, mounted on card-points, in balsam on slides, and in alcohol, U. S. National Museum Type No. 43939; reared in vast numbers from seeds of logwood, *Haematoxylon campechianum* L. Hinche, Haiti, Jan. 18, 1930, and at Damien, Haiti, Feb.–March 1931 by the writer.

Larva. Length .85 mm. The fullgrown larva is 13-segmented, the anterior three segments being distinctly wider than the remainder. Pale creamish white in color.

Pupa. Length 1.75 mm.; greatest width .75 mm. Pale creamish color at first but as development proceeds the eyes become distinctly reddish and the mandibles take on a reddish, chitinized appearance. Just prior to issuance of the adult, the pupa becomes very much darkened.

DISTRIBUTION

The logwood is indigeous chiefly to the mainland of tropical America, being most abundant in southern Mexico (Tobasco, Campeche and Yucatan) and throughout Central America, and fairly common in Colombia, Venezuela and the Guianas. It seems to be possibly native to Hispaniola, as the wood is said to have been exported from Santo Domingo to Spain in the latter part of the sixteenth cen-

Figure 2.—Cluster of logwood seeds, completely destroyed by the work of *Tanaostigma haematoxyli*, new species, slightly reduced (original)

tury. It is called "campeche" in Haiti, and there as well as in Jamaica is the chief honey plant of the island. It was reported as having been introduced into Jamaica about 1715 by means of seed from Honduras. It would therefore be very interesting to find out if the seeds are attacked by this wasp in the other parts of its range.

A letter from Mr. H. H. Coote, Instructor in Beekeeping in Ja-

maica, dated Feb. 25, 1930, states "From the beekeeping standpoint we look at the logwood as a great asset and although it is attacked here by a similar insect we have no reason to be alarmed as we have more young trees coming forward than those that are cut down for commercial purposes". In Haiti, however, the logwood is being rapidly and relentlessly cut out for export for the dye industry and this together with the destruction of 90 per cent of its annual seed crop by this wasp accounts for the diminishing amount available in that country and for the poorer honey yields of more recent years.

Figure 3.—Seed-pods of logwood, *Haematoxylon campechianum* L., in various stages of development, showing oviposition scars and exit holes, natural size (original)

SEASONAL OBSERVATIONS

The main flowering of the logwood and consequent honey-flow in the vicinity of Damien, Haiti, starts in January and there is nearly always a second blooming. In other sections of the island there are as many as three different extractions. In the Hinche region the log-

wood usually starts to bloom about November 29th with the largest honey-flow starting again in January. As the logwood is rather irregular in blooming we find usually some straggling or late blooms at the same time as young and fully-developed pods and as the blooming season varies with different regions it appears that this wasp carries itself over from one season to the next without difficulty.

The writer observed the logwood in full bloom at Hinche, in the Central Plains district, on Jan. 9, 1930. On this date vast numbers of a very small greenish-yellow psyllid, nymphs and adults, were present on every flower cluster examined and these were turning black and drying up as a result of the continual sucking of these small insects. Old seed pods still clinging to the trees showed hundreds of adult *Tanaostigma* issuing. A second trip made January 16th showed practically no new seed had set, all of the flower clusters having dried up. Automatically with this the honey-flow ceased. From the old pods thousands of the *Tanaostigma* were still issuing to continue the destruction of any seed that might have set.

At Damien and Port-au-Prince adult *Tanaostigma,* the first observed in 1930, started issuing on February 2nd in vast numbers. The writer observed a few adults of the same psyllid and a few *Tanaostigma* adults at logwood bloom near St. Michel du Sud on Feb. 17th and from seed pods collected at Fond-des-Negres the first adults started to issue Feb. 18th. During February observations were made by Messrs. G. Kolbjornsen and A. Daumec, Agricultural Inspectors, throughout the entire Artibonite valley and they reported practically 100-per-cent destruction of logwood seed wherever examined, finding only exit holes as the adults had already issued. Attacked seed was reported by Mr. Parisot at Thozin in the Commune of Grand Goave, March 16, 1930.

Close observations were made during 1931. The logwood started to bloom in the regions of Port-au-Prince and Damien about January 1st. At Verrette the writer observed newly formed pods with very young larvae of *Tanaostigma* developing inside the seeds on Jan. 15th. By February 28th the large new crop of seed pods at Damien showed 100-per-cent infestation but only a few of the adults had issued by that date. A large amount of material was placed in battery jars and field observations continued. By March 20th nearly all of the adults had issued. Due to the prolonged flowering, even at that date there were a few late blooms on the same trees and the young pods practically all contained pupae.

HABITS AND CHARACTER OF INJURY

The adult wasps soon after issuing were observed to start mating, actively running over the seed pods. The eggs are extremely small and are deposited within the young tender pods by means of the ovipositor. The oviposition scars are readily visible from the outside and each seed is occupied by a larva. The consequent reaction produces a gall-like deformation of the seeds and with it the pod is definitely thickened along the middle. Fig. 3 shows various seed pods, illustrating the different stages of development from the oviposition scars to the exit holes of the adults.

The result is that in many cases every seed in the entire cluster of pods is completely destroyed. In this way the logwood is prevented from re-seeding itself. Observations made over the two-year period show that this is serious. Fortunately, however, the logwood is so prolific that it is probably capable of producing enough seedlings to replace itself if freed, even at long intervals, from the attack of this wasp by unusual activity and restraint on the part of its parasites.

PARASITISM

On March 16, 1931, the contents of one rearing jar were examined and counted with hand tabulators, yielding 5223 adult *Tanaostigma* and 352 parasites or 6.75-per-cent parasitism. There were two species of parasites involved and these have been determined by Mr. Gahan as *Eupelmus* sp. and *Horismenus* sp., the latter being the smallest and of a distinct metallic green color.

THE ANNONA SEED CHALCID

DISTRIBUTION

This rather large chalcid wasp, *Bephrata cubensis* Ashmead, was described in 1894 (Descr. New Parasitic Hymneoptera, Trans. Am. Ent. Soc., vol. 21, p. 321, Sept.). The first record of its attacking *Annona* seeds was that published by J. C. Crawford (Proc. U. S. National Museum, vol. 41, p. 274, 1911). There are specimens in the U. S. National Museum, determined by Mr. Gahan, reared from *Annona* seeds at Santiago de las Vegas, Cuba, by P. Cardin, Dec. 26, 1910; from seeds of the custard apple and sour sop at Cross Roads, Jamaica, A. H. Ritchie; and from *Annona squamosa* fruit at Miami, Florida, Dec. 15, 1921, reared by G. F. Moznette. In addition, the writer observed the exit holes of this insect to be numerous in fruits

of the "guanábana", *Annona muricata,* in Porto Rico in 1925 * and has reared adults in Haiti in 1931. This shows that *Bephrata cubensis* has a rather wide range through the West Indies at least and occurs in Florida.

TECHNICAL DESCRIPTION

Female. Length 6.5–7.25 mm. Of a testaceous to rufous-orange color when fresh, except for the petiole and last thoracic joint adjoining which are black. Antennae with scape pale, marked with fuscous adjoining the dark pedicel; the entire funicle deep brownish-orange, turning darker after death. Eyes red. Ocelli

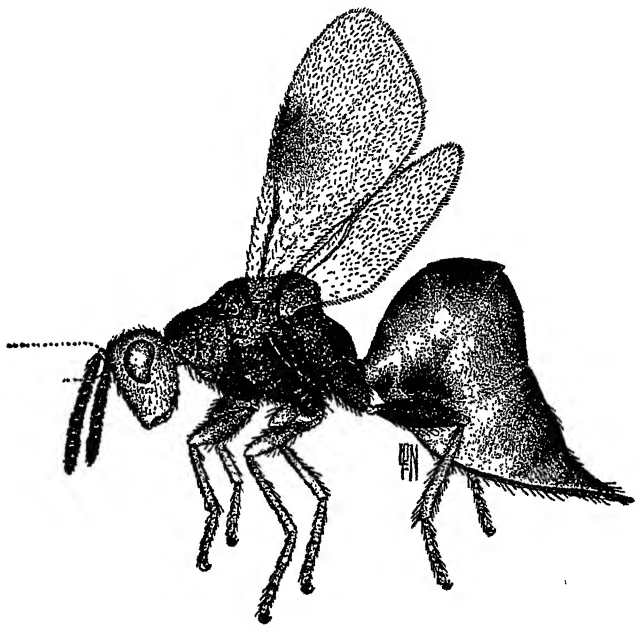


Figure 4.—Adult female wasp, *Bephrata cubensis* Ashmed, that attacks the seed of annonaceous fruits, greatly enlarged (original)

black. Legs testaceous except for slight infuscation on the femora. Umbilicately punctate, the head, thorax and petiole dull. Petiole short. Abdomen shiny, much compressed, slightly longer than the head and thorax combined, roundingly and prominently elevated from the base, then depressed downwards in a rounding curve to a pointed tip from which the ovipositor projects slightly. Frons with a deep antennal groove. Wings hyaline with a distinct fuscous cloud or infumation beneath the marginal vein.

Male unknown.

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* This seed chalcid was reported by C. G. Anderson (determined by C. F. W. Muesebeck) as infesting one out of four fruits of "corazón", *Annona reticulata,* examined at Villalba on October 27, 1931—Editor's Note.

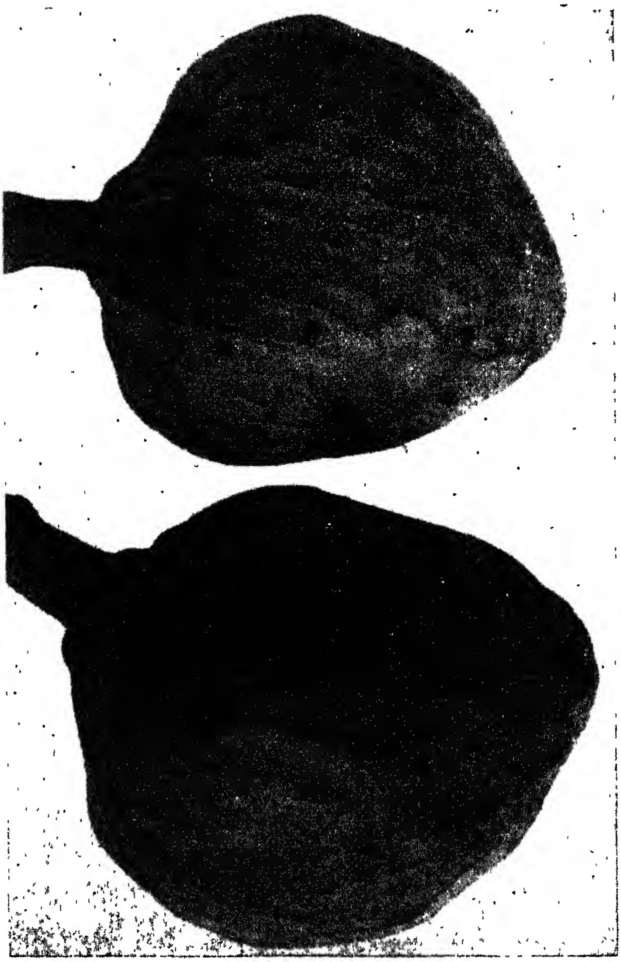

Figure 5.—Fruits of *Annona reticulata* showing openings through which *Bephrata cubensis* have emerged.

OBSERVATIONS

Fruits of "cachiman coeur-boeuf", *Annona reticulata,* were collected at Damien Haiti, on April 16, 1931 and were placed in rearing jars. On that date exit holes were already present in various fruits and during the period from the 17th to the 24th, a total of 17 females were reared from this fruit. The adult Eurytomid wasp lays her eggs in the young developing fruits and the larvae develope inside of the seeds, gradually consuming them. The insect leaves the fruits as an adult, gnawing exit holes as shown in Fig. 5. Similar holes are very common in fruit of the "corosol", *Annona muricata,* in Haiti, and three adults were reared from this fruit May 3, 1931.

REFERENCES

1922 **Gahan, A. B.** A List of Phytophagous Chalcidoidea with Descriptions of Two New Species. Proc. Ent. Soc. Wash., vol. **24,** February.

1890 **Howard, L. O.** A New and Remarkable Encyrtid: Is it Parasitic?, Insect. Life, vol **3,** p. 147.

THREE SPECIES OF *EMPOASCA* LEAFHOPPERS KNOWN TO AFFECT ECONOMIC PLANTS IN HAITI (INCLUDING THE DESCRIPTION OF TWO NEW SPECIES)*

By Dwight M. DeLong
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For many years it has been the opinion of entomologists that *Empoasca fabae* Harris, the potato leafhopper was a pest occurring in all parts of the United States and Central and South America. Recently the writer [1] has been able to distinguish the species of Empoasca by the male genital pieces and has then shown by field studies [2] that other important species are concerned and that these instead of *fabae* are the important economic forms in certain areas of the United States. Following this study of characters, Dr. R. C. Smith then located at Port-au-Prince, Haiti, forwarded to the writer a large series of specimens collected from beans and sweetpotatoes in that locality. Upon examination it was found that these were not *fabae* and the species was described as *E. fabalis* DeL.[3] According to the survey made by Dr. Smith when these specimens were collected the species was extremely abundant upon beans and sweetpotatoes and was considered the most important species of economic leafhopper in Haiti upon truck crops.

More recently Dr. H. L. Dozier forwarded three different lots of material collected in the same area one of which has proven to be *fabalis* which he collected from sweetpotatoes. The other two species, one collected from cotton and another from *Canavalia* are apparently undescribed. There is a possibility therefore that the three have been considered as one species and each of these may be important economically. The descriptions together with an illustration of the male genital structures of each are included below.

Empoasca fabalis DeLong.

Canadian Entomologist LXII p. 92 April 1930.

Resembling *fabae* in size, form and appearance but with distinct genital characters. Length 3 mm.

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* Editor's Note: *E. fabalis* is widely distributed and injurious to lima and string beans in Puerto Rico and has also been reported as injurious to tomato. The species commonly present on sweet potato here has not as yet been specifically determined but is quite probably *fabalis*. The cotton leafhopper in Porto Rico may also be *E. gossypii* herein described as new.

[1] U. S. D. A. Tech. Bull. 231, January, 1931.

[2] Jour. Eco. Ent. Vol. 24, p. 475–480, April, 1931.

[3] Canadian Entomologist LXII, p. 92, April, 1930.

Vertex strongly produced about one-third its length before anterior margins of eyes. One-third wider between eyes than length at middle. Pronotum one-third longer than vertex.

Color pale green without distinct markings. Usually with irregular mottling and varying longitudinal stripes, white. A pair of oblique dark green spots either side of, and back of apex.

Genitalia: Female last ventral segment roundingly produced and entire. Male valve twice as long as preceding segment, posterior margin almost truncate. Plates long and narrow, gradually tapered to rather acute tips, more than twice as long as valve.

Male internal genital structures: In ventral view styles short, slender, very narrow at apices which are bent outwardly. Lateral processes of pygofers long and tapered. Apical fifth very narrow and slightly bent inwardly (in ventral view). Dorsal spines of pygofers heavy at base but rapidly narrowed to ventrally directed and slightly anteriorly hooked processes.

Empoasca gossypii new species.

Appearance and general form of *fabae* but smaller and with distinct male genitalia. Length 2.8 mm.

Vertex almost one-third wider between eyes than length at middle. Pronotum two-fifths wider than long. Humeral angles prominent, posterior margin strongly concave.

Color greenish marked with white and yellow. Vertex yellowish green mottled with white. Pronotum yellowish, subhyaline. Anterior and lateral margins marked with white. Scutellum mostly white. Elytra greenish, subhyaline with yellowish green longitudinal stripping sometimes very faintly colored.

Genitalia: Female last ventral segment as long as basal width. Posterior margin with lateral angles rounded and slightly indented either side of a median slightly produced broadly angled lobe which is about half the width of the segment. Male plates more than two and one-half times as long as combined width at base rapidly narrowed to compressed, flaring, and upturned apices. Ventrally set with long brownish spines.

Male internal genital structures: Styles strongly curved outward apically in ventral view. Lateral processes of pygofers short and rather stout, gently curved dorsally. Dorsal spines of pygofers wide at base curved ventrally, bifurcate apically.

This is the only species of Empoasca except *bifurcata*, a common species in the Eastern United States, which is known to have a bifurcate dorsal spine. It can easily be distinguished from the other described species in Haiti by this character.

Described from 35 female and male specimens collected from cotton at Hinche, Haiti, September 12, 1931, by Dr. H. L. Dozier.

Holotype male labeled Hinche, Haiti, September 12, 1931.

Empoasca canavalia new species.

Resembling *fabae* in general appearance but smaller and with distinct male and female genital characters. Length 2.8 mm.

Vertex bluntly angularly produced almost one-third wider between eyes than length at middle. Pronotum more than twice as wide as long. Elytra exceeding abdomen by about one-fourth their length.

Color variable, usually some shade of green. Vertex yellowish or orange yellow marked with green. Two rather bright green areas on disc either side of vertex. Pronotum and elytra greenish subhyaline.

Genitalia: Female last ventral segment two-thirds as long as basel width. Posterior margin concavely rounded to produced central tooth which is more than one-third the width of the segment and is slightly notched at center. Male plates one-third longer than combined width at base apices rather sharply pointed and upturned. Sides straight.

Male internal genital structures: In ventral view styles gently curved outwardly. Lateral processes of pygofers as seen in lateral view rather broad, constricted near apex and terminated by a slender curved finger process. Dorsal spines of pygofers large, broad at base, produced downward and inwardly, appearing to cross each other in ventral view, gradually tapering to pointed tips.

Described from 48 female and male specimens collected from Jack Bean, *Canavalia ensiformis* (L) D. C. at Damien, Haiti. September 14, 1931, by Dr. H. L. Dozier who sent them to the writer for identification.

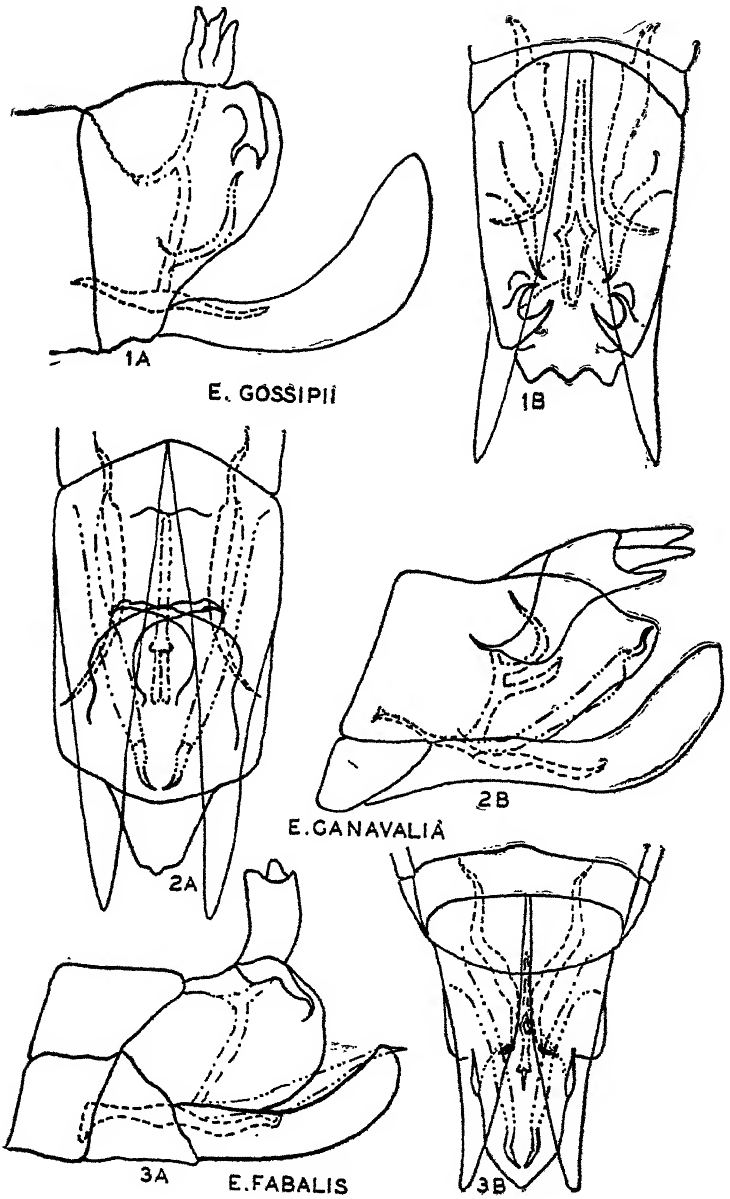
Holotype male labeled Damien, Haiti, September 14, 1931.

EXPLANATION OF PLATE XIII

(SHOWING MALE GENITALIA)

1 A.—E. gossipii n. sp. lateral view
1 B.—E. gossipii n. sp. ventral view
2 A.—E. canavalia n. sp. ventral view
2 B.—E. canavalia n. sp. lateral view
3 A.—E. fabalis De L. lateral view
3 B.—E. fabalis De L. ventral view
-------------Style
—.—.—.—.oedagus
—...—...— lateral process of pygopher

PLATE XIII



A NEW CITRUS CAMBIUM MINER FROM PUERTO RICO

By E. P. Felt
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The species described below was reared by Dr. G. N. Wolcott from larvae working as cambium miners in grapefruit twigs about the diameter of one's finger and causing a darkened discoloration of the twigs. The larvae of this Itonid made cocoons in the soil July 11 and the adults emerged July 15, 1931 at Isabela, Puerto Rico. The material was submitted for study later that month by Dr. M. D. Leonard, Chief Entomologist of the Insular Experiment Station, Río Piedras.

The species is rather closely related to the West Indian *Asynapta mangiferae* Felt, a species reared from larvae working under the bark of small twigs of grafted mango, probably *Mangifera indica*. (See Entomological News, **20**: 299. 1909.)

Asynapta citrinae new species.

The new species may be differentiated by the larger number of antennal segments, the longer stem of the fifth antennal segment and the decidedly shorter length of the enlargement in the male, and the decidedly longer subcylindrical fifth antennal segment in the female.

Larva. Length, 3 mm., yellowish white, tapering anteriorly, a rudimentary breast bone, posterior extremity truncate, ventrally indistinctly bilobed.

Male. Length, 1.75 mm. Antennae as long as the body, sparsely haired, fuscous yellowish; 24 segments, the fifth with a stem as long as the basal enlargement, the latter with a length one-fourth greater than the diameter; the terminal segment reduced, the basal portion with a length about three-fourths its diameter, apically short and stout. Palpi; first segment subquadrate with a length about twice the diameter, the second a littte longer than the first, more slender, the third one-half longer than the second, more slender, the fourth one-fourth longer than the third and more slender. Head fuscous yellowish, eyes large, black. Mesonotum, fuscous yellowish. Scutellum and postscutellum, yellowish. Abdomen, fuscous yellowish, the segments rather thickly haired distally. Genitalia yellowish. Wings hyaline. Halteres pale yellowish. Coxae and femora mostly pale yellowish, tibiae and tarsi pale straw. Claws stout, unidentate. The pulvilli rudimentary. Genitalia indistinct in the preparation.

Female. Length, 1.75 mm. Antennae about three-fourths the length of the body, thickly haired, pale yellowish; 24 subsessile segments, the fifth with a length one-fourth longer than the diameter; the terminal segment somewhat produced, narrowly conical, with a length nearly twice its diameter. Palpi; prac-

tically as in the male. Head, pale yellowish, eyes large, black. Mesonotum, pale orange yellow. Scutellum and postscutellum, yellowish white. Abdomen, pale yellowish. The ovipositor short, basal lobe subquadrate with a length about one-half greater than its diameter, the terminal lobe narrowly oval, sparsely haired. Wings hyaline. Halteres pale yellowish. Coxae and femora basally whitish, the femora distally, tibiae and tarsi pale straw.

Types deposited in the United States National Museum.

A NEW NEOTROPICAL GENUS OF EUPTERYGINAE (HOMOPTERA) FROM PUERTO RICO

By W. L. McAtee,
U. S. Bureau of Biological Survey, Washington, D. C.

Specimens of this new form have been on hand for a decade or more, but the need of describing it did not become apparent until it was sent in as an "economic" insect. Recent collections indicate that the leafhopper is injurious to the mamey (*Mammea americana*) or so-called tropical apricot.

Among Euteryginae the genus is characterized first by lacking an appendix to the tegmen, and by having the apical cells of the wing closed posteriorly. It belongs therefore in the tribe Dikraneurini, and in that group its diagnostic characters are: Submarginal vein of wing approaching costal margin, not continuous with first sector, cross veins completely lacking; cross vein one lacking in tegmen, and apical veins of tegmen straight and parallel. They are also practically direct extensions of the sectors.

The name *Hybla* is proposed for the genus and the genotype is the following species:

Hybla maculata new species

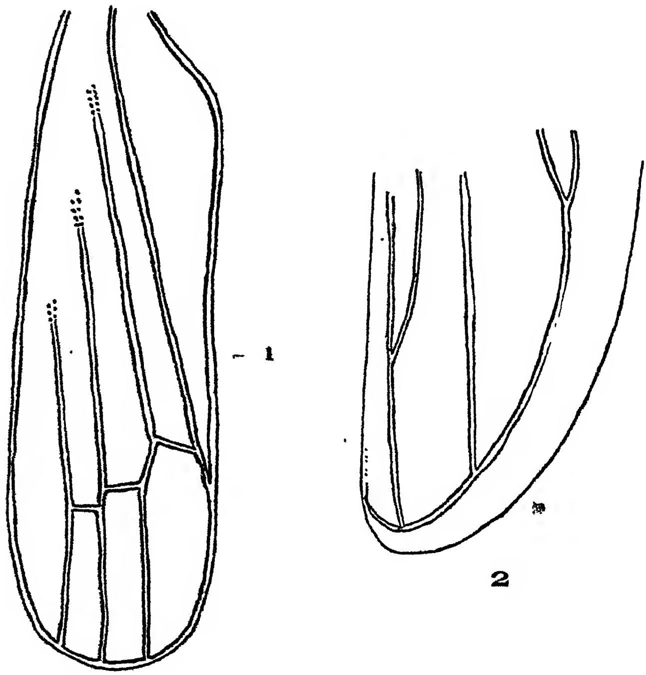
Form distinctly depressed; vertex subangulate anteriorly, about equal in length to pronotum; head across eyes wider than pronotum; venation as shown in the accompanying figures (which were sketched by J. R. Malloch and inked in to their detriment by the writer).

General color pale lemon yellow above, whitish below. The dorsal surface is ornamented by a number of black spots of which pairs on the vertex, pronotum, and clavi are conspicuous. There is a small spot near base of each corium, another on corium near middle of claval suture, a spot at each end of costal plaque, of which the hinder about equals in size that near base of clavus, these being the largest of all. There is a small spot near apex of clavus, one in vicinity of junction of third sector and the corresponding apical vein. All of these spots are discrete, dense, and more or less elliptical in shape. The apex of tegmen is somewhat fumose, with denser blackish cloudings or even dense spots in both the (hypothetical) first and in the fourth apical cells. The eyes are greenish black, and there is a black spot on each mesopleurum. The spots vary somewhat in size and intensity, the pair on vertex being reduced in several specimens and entirely lacking in a few. Length 2.2–2.3 mm.

Described from a number of specimens of both sexes, including therefore both the holotype and allotype, labelled Barceloneta, Puerto Rico, May 3, 1932, on mamey, R. Faxon and A. C. Mills; and others

from the same locality and food plant, March 22, 1932, A. S. Mills and C. G. Anderson: Pt. Cangrejos, Puerto Rico, Jan. 13, 1920, G. N. Wolcott; and Santo Domingo, G. N. Wolcott. (All material in the United States National Museum.)

There may be some tendency to confuse this species with the spotted form (*moznettei*) of *Empoasca minuenda* Ball.* The arrangement of the spots, however, is different in that insect, which furthermore is not at all depressed in form. Both of these forms in contrast to *Empoasca* belong to the section of Dikraneurini that



LEGEND FOR FIGURES

1. Tegmen, 2. Wing, of *Hybla maculata*.

has the submarginal vein of the wing connivent or nearly so with the costal margin and not continuous with the first sector. *Hybla maculata* lacks, while *minuenda* possesses, a crossvein in the wing. *Empoasca minuenda* was named ** by DeLong as the type species of a subgenus *Idona* of *Empoasca;* it is not an *Empoasca* however and apparently must be recognized as a distinct genus.

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* Proc. Biol. Soc. Wash. 34, pp. 23–24, March 1921 [Florida].

** Tech. Bul. 231, U. S. Dept. Agr., Jan. 1931, p. 50.

INSECT CONDITIONS IN PUERTO RICO DURING THE FISCAL YEAR, JULY 1, 1930 THRU JUNE 30, 1931

By M. D. Leonard
Entomologist, Insular Experiment Station, Río Piedras, P. R.

ALFALFA

The alfalfa leaf-tyer, *Dichomeris piperatus* Wlsm., was injurous on the experimental plots at the Isabela Sub-Station from April thru June but possibly not quite so injurious as last year, especially during April; no observations were made during the first half of the year but the insect was surely present.

The fall armyworm, *Laphygma frugiperda* S. & A., did considerable damage in June, 1931 at the Isabela Sub-Station but was checked by being eaten by the giant toad, *Bufo marinus* L., which ate the caterpillars after the alfalfa was cut.

BAMBOO

The bamboo scale, *Asterolecanium bambusae* Bvd. (H. Morrison det.) was reported as heavily infesting bamboo at Cidra and at Mayagüez in August and September (A. S. Mills) and as infesting bamboo at Maricao in January (A. G. Harley). It was however undoubtedly generally distributed and common throughout the Island.

BANANA

The banana root-borer, *Cosmopolites sordidus* Germ., was more or less injurious throughout nearly all parts of the Island, its status undoubtedly being about the same as during the previous year. During March and April however a survey made on about 800 farms compirsing about 50,000 acres in the Districts of Ponce, Guayanilla and Peñuelas which were previously thought to be free of the pest or nearly so, showed that Ponce ranged from 7–20 per cent infested and initial infestations were found scattered thruout the other two Districts.

The West Indian cane weevil: *Metamasius hemipterus* L. was reported as abundant and generally distributed in the bananas examined in the above survey.

BEANS

The lima bean pod-borer, *Maruca testulalis* Geyer, was undoubtedly present wherever lima or string beans were grown in the Island but has actually been observed only at Río Piedras, Isabela, Mayagüez and Cidra. All indications point to the fact that it is more abundant during the fall and winter months and scarce to sometimes absent during the summer. The fact that beans both string and limas are more commonly grown during the winter is undoubtedly largely but probably not entirely responsible for this difference in abundance.

Another bean pod-borer, *Etiella zinckenella* Treit., has been found to be widely distributed and fairly abundant at least in the lower parts of the Island; it also occurs in Vieques Island. During the spring it was considerably more common at Isabela than Maruca as a bean pod-borer and the same was true but possibly to a somewhat less extent at Río Piedras during the previous fall and summer. We have reared it in the latter place during the summer and fall of 1931 from lima beans crotalaria, cowpeas, and pigeon peas, in which latter it is even more common than in lima beans.

The cowpea pod and stalk borer, *Fundella cistipennis* Dyar., was reared a number of times from lima beans during May 1930 and altho it was not observed infesting beans during the past fiscal year it was undoubtedly present in fair numbers.

A leaf beetle, *Ceratoma denticornis* Fab., was fairly common on string beans at the Station during March and April but apparently not doing much damage. No other definite observations were made during the year but the insect was probably fairly common and general as is usual wherever string beans were grown.

A leaf-beetle, *Diabrotica graminea* Baly, was present and fairly common in several places observed but doing only moderate damage to string beans. It was also recorded on Irish potatoes and mung beans in June, both of which see.

The bean lace-bug, *Corythucha gossypii* Fab., has been moderate to abundant and injurious to both lima and string beans wherever grown and more or less thruout the year, altho as usual it was more abundant and injurious during the summer months.

The corn earworm, *Heliothis obsoleta* Fab., was found lightly infesting about 1 per cent of the pods at harvest time of about 1 acre of string beans at the Station at Río Piedras.

A leafhopper, *Empoasca fabalis* De Long, was moderated to abundant and injurious to both lima and string beans wherever grown thruout the year; several patches of string beans observed which had

not been sprayed were practically destroyed by the insects which were extremely abundant.

The bean leaf-roller, *Goniurus proteus* L., was present in most plantings of both string and lima beans observed during the year but as a rule not doing a great deal of damage.

The bean leaf-webber, *Lamprosema indicata* Fab., was only observed doing moderate damage at Río Piedras in several plantings of lima beans during the late fall.

Larvae of the greenhouse leaf-tyer, *Phlyctaenia rubigalis* Gn., were observed as doing considerable damage to the foliage of string beans in January and February.

Larvae of the rattlebox moth, *Utethesia ornatrix* L., were abundant in string-bean pods at Río Piedras in January and February.

"Vaquitas," *Diaprepes spengleri* L., were observed eating the leaves of string beans to a considerable extent at Isabela in January or February.

The bean aphid, *Aphis rumicis* L., was observed lightly infesting a ½-acre patch of string beans at Manatí on Mar. 7, 1931 (A. S. Mills & E. G. Anderson; P. W. Mason det.). This is apparently the first definite record of the insect for Porto Rico.

The eggplant stem-borer, *Baris torquatus* Oliv., on beans (See under eggplant.

BEETS

A leaf-beetle, *Disonycha laevigata* Jacoby, was abundant and doing considerable damage to a fair-sized garden patch of both beets and Swiss chard at Palo Seco on Aug. 29, 1930. The grower stated that these beetles had troubled him for several years and had necessitated constant control measures (M. D. Leonard & A. S. Mills).

Moths of the smaller beet webworm, *Hymenia fascialis* Cramer, were not uncommon at lights at Aguirre the end of June. Infested beets were only observed at Palo Seco, mentioned above, at which time they, as well as the Swiss chard, were infested to a considerable extent with this webworm.

BIDENS PILOSA

See *Protalebra brasiliensis* De Long under SUGAR CANE.

CABBAGE

The diamond black moth, *Plutella maculipennis* Curtis, was abundant and injurious thruout the year wherever cabbage was grown, but as usual was less active during the winter months.

A leaf-miner, probably *Agromyza inaequalis* Malloch, was fairly common on plants grown at the Station in Río Piedras in April; definite observations were not made during the rest of the year.

A weevil, *Lachnopus curvipes* Fab., was found on a cabbage plant at Río Piedras, Jan. 5, 1931 (Mills and Anderson; L. L. Buchannan det.).

CACTUS

The cactus scale, *Diaspis echinocacti opuntiae* Ckll. (Morrison det.) on a cactus (Opuntia ?), Coamo Sept. 30, 1930 (A. G. Harley) and one plant of *Opuntia brasiliense,* moderately infested in Santurce, Mar. 24, 1931 (R. Faxon and A. S. Mills).

CARNATION

A scale insect, *Pseudoparlatoria ostreata* Ckll. (Morrison det.), was submitted the end of June by M. A. Díaz of the Department of Agriculture with the report that it was badly infesting a number of plants in a garden at Martin Peña.

CASSAVA

Red spiders, *Tetranychus* sp., were somewhat less abundant and injurious during the fall than during the spring and summer of 1930 due to more rain in the fall.

The cassava shoot-borer, *Lonchaea chalybea* Weid., was common on isolated plants at the Station thruout the year.

CASTOR BEAN

The bean lace-bug, *Corythucha gossypii* Fab., was present in moderate numbers on castor-bean foliage in several localities observed in the late summer of 1930 but was undoubtedly present to a greater or less extent in all parts of the Island thruout the year.

CHAYOTE

The pickle worm, *Diaphania nitidalis* Cramer, was first found infesting about 20 per cent of the fruits in one of the largest plantings in Lares in October, 1930. From then on into March fruits were found at frequent intervals in the market in Río Piedras averaging 5–10 per cent infested. Since that time no observations have been made First record of definite food-plant or locality for Porto Rico.

CITRUS

Scale insects, principally the purple scale, *Lepidosaphes beckii* Newm. and the Florida red scale, *Chrysomphalus ficus* Ashm. were apparently general and about as injurious as usual, several large growers reporting them worse than during the previous year and other growers as not so abundant.

The green scale, *Coccus viridis* Green, was obtained early in June lightly infesting a number of young grapefruit trees at the Isabela Sub-Station. It was probably on citrus in other places but observations were not made except near Isabela where during the month infestations of green scale almost disappeared from at least 4 grapefruit plantings observed due to heavy rains, growth of windbreaks and spraying with oil combined.

The woolly white fly, *Aleurothrixus floccosus* Mask., moderately infested about 20 young Meyer lemon trees on the Station grounds in April at Río Piedras.

The rust mite, *Phyllocoptes oleivorus* Ashm., was apparently not as injurious on the whole as during the previous year.

The "vaquita grande", *Diaprepes spengleri* L., did considerable damage as usual especially during May and June to the foliage in the citrus sections by entirely stripping off new growths and by the larvae injuring the roots. It was reported that in the Bayamón section the adults caused considerable drop of young grapefruits (tho no more than usual) by cutting them off at the point of attachment to the stems.

The "vaquita verde", *Exopthalmodes roseipes* Chev., also did some damage to foliage in the main citrus section during the summer and according to one of the best growers caused some injury to the fruits in June 1931 in his locality.

June beetles, undoubtedly involving mostly *Phyllophaga vandinei* Smyth, and *P. citri* Smyth, were injurious to both young and old trees due to feeding of the adults on the leaves (mostly during May and June) and the larvae on the roots. In January about ⅓ of 30,000 grape fruit seedlings were reported killed by white grubs in a nursery at Bayamón. It is felt, however, that these insects have been less injurious during the past 2 or 3 years than formerly in at least the older parts of the citrus-growing section around Bayamón due to the introduction in 1926 of the toad, *Bufo marinus* L., in small numbers into several groves and their subsequent great increase. One large grower stated that he had found as high as 20 beetles in the stomach of a single toad.

Ants, especially the brown ant, or "hormiga brava", *Solenopsis geminata* Fab., were injurious to citrus as usual and required control measures by many growers.

Thrips injury to citrus fruits has only once before been recorded in Porto Rico. During the past year the writer has several times observed thrips in fair numbers in the blossoms but no specimens were collected for determination. Many grape-fruits have also been seen in several packing houses which certainly show characteristic "thrips injury" but more detailed observations will have to be made.

The bean lace-bug, *Corythucha gossypii* Fab., was found for the first time in Porto Rico moderately infesting several young lemon and orange trees at Isabela in April; in May a light infestation of several young grapefruit trees was observed at Río Piedras. It is interesting to note that recently Brunner observed the insect on citron foliage in Cuba.

A very common injury to oranges has been prevalent again this past year in several parts of the citrus growing section, especially the Eastern part. When the fruits are fully-grown but still green to nearly ripe a very small hole is often found underneath which the pulp becomes soft and juicy and breaks down. Often these holes are enlarged apparently by birds which probably peck into them to extract the larvae of such scavangers as Nitidulid beetles, *Drosophila* larvae and especially larvae of the spotted rootfly, *Euxesta notata* Wiedemann, which latter has often been found therein and adults reared. The real cause of the original small holes is not known, but certainly the Euxesta fly is not primarily responsible. Considerable loss occurred to a number of growers during the year.

A leaf-footed plant-bug, *Leptoglossus gonagra* Fab., did considerable injury from the latter part of November into December in a 65-acre grape-fruit grove at Pueblo Viejo. At the same time about 10 acres of grapefruits were attacked a little west of Bayamón and caused about 10 per cent of the fruits to drop. The bugs were in enormous numbers and were breeding on the wild balsam apple, *Momordica charantia* L., which was very common in the grove. The adults flew to the ripening fruits and made small feeding punctures under which the pulp became broken down and often had a slightly rotten odor and a bitter taste. By the first of January all trouble was over and it was reported that very few of the bugs could be found in either grove.

The Fulgorids, *Bothriocera bicornis* Fab. and *Ormenis infuscata* Stal. (P. W. Oman det.), on grapefruit leaves at Añasco, Nov. 5, 1930 (A. G. Harley).

CANNA

The canna leaf-roller, *Calpodes ethlius* Cramer, was observed early in June to be moderately infesting a number of plants at Isabela.

COCONUT

Rhinoceros beetle, *Strataegus quadrifoveatus* P. de B., was generally distributed and destructive thruout the whole coastal area of the Island. It was most abundant however in the coconut-growing sections of the following municipalities: (Western Section) Aguadilla, Aguada, Moca, Rincón, Añasco, Mayagüez, Hormigueros, Cabo Rojo and Lajas; (Northern Section) Barceloneta, Manatí, Vega Baja, Vega Alta, Carolina and Loíza; (Eastern Section) Yabucoa and Humacao. In these an intensive clean-up campaign was carried on by the Agricultural Extension Division from September to July during which there were collected a total of 370,844 larvae and of 27,498 beetles by boys to whom a total of $3,354.49 was paid. They received from 5 to 10 cents per dozen.

The coconut scale, *Aspidiotus destructor* Signoret, according to Mr. Ferdinand Méndez, in charge of the coconut bud-rot clean-up campaign, was generally distributed throughout the Island. It was particularly injurious however at Boquerón near Cabo Rojo and at Patillas. At Boquerón serious damage was done to a young plantation and at Patillas many old bearing trees were badly infested.

COFFEE

Adults of the coffee stem-borer, *Apate francisca* Fab. were taken from dead twigs of tamarind at Tallaboa by A. G. Harley on Nov. 8, 1930 (W. S. Fisher det.). In March there was a severe infestation at Lares in which about 100 coffee trees on about 1 acre were injured; guava were also injured and an orange, an aguacate and some pomarrosa (*Jambos Jambos*) fence posts were also slightly injured; burrows were also found in two achiote trees (*Bixa orellana* L.) and 50 infested pigeon-pea plants had been cut and burned. A couple of weeks later early in April the infestation had apparently subsided. A few coffee trees were reported infested at Guayanilla during April.

The green scale, *Coccus viridis* Green, was collected by Faxon, Harley and Mills of the U. S. P. Q. & C. A., (det. by Morrison,) on June 25, 1931, on coffee at Maricao but abundance was not stated. In April it was observed lightly infesting several varieties at the Station in Río Piedras and in June a number of young grapefruit

trees at the Isabela Sub-Station were found lightly infested. It is undoubtedly widely distributed in Porto Rico on coffee and citrus.

The coffee leaf miner. *Leucoptera coffeella* Staint., was present in greater or less abundance in all coffee plantations thruout the year, being more abundant and injurious, as usual, in the dryer sections; systematic spraying was necessary in seedbeds thruout the Island. In October and November cocoons were collected at Lares to determine the percentage of parasitism. These were taken only from a dry locality. Out of 871 cocoons 645 moths emerged and only 7 parasites, all of which were *Chrysocharis lividus* Cresson.

The coffee shade tree ant or "hormiguilla" *Myrmelachista ambigua* Forel var. *ramulorum* Wheeler, was generally present thruout the coffee growing sections but during last year and since the hurricane of 1928 has been less abundant and injurious than formerly due to the destruction of so many of the large coffee shade trees; the ants are less abundant or at least less in evidence during wet weather.

The hemispherical scale, *Saissetia hemispherica* Targ., was reported abundant and causing considerable sooty mould on coffee trees at Guayanilla during April.

A light infestation of *Pseudococcus citri* Risso, was observed during April on a small variety planting at the Station at Río Piedras.

Mothis of the coffee stem-borer, *Psychonoctua personalis* Grote, were caught at light at Cataño on April 24, 1930; Coamo Springs, April 4, 1930 and at Puerto Real, Vieques Island, on April 28–29, 1930, as well as at Aguirre, May 22, but only a few specimens atlogether. The work of the larva was not observed during the year but it was undoubtedly present in the coffee sections to some extent as usual.

Several adults of a leaf-hopper, *Cicadella coffeacola* Doz., were taken on a coffee tree at Maricao, Dec. 11, 1930 (A. G. Harley; P. W. Oman det.).

COFFEE SHADE-TREES

Glyricidia sepium (Jacq.) Stend. In June a scale, *Howardia biclavis* Comst., was noticed as abundant on a number of these shade trees in a good-sized experimental plot of coffee at the Mayagüez Station; it had been present for several years according to T. B. McClelland and had considerably interfered with the growth of the trees.

Cedro hembra, *Turpinia paniculata* Vent. A lepidopterous shoot-borer, *Hypsiphyla grandella* Zell., (a Phycitid; Heinrich det.) was

reported during June as having done considerable damage to about 4,000 young trees at Jayuya and to about 1,000 young trees recently planted at Adjuntas in June, 1931; a number of young trees were moderately infested at Lares.

CORN

The corn earworm, *Heliothis obsoleta* Fab., was without doubt generally present and injurious wherever corn was grown altho but few specific reports were received or observations made.

COTTON

The pink boll-worm, *Pectinophora gossypiella* Saund., has been for more abundant than ever before and assumed the proportions of a first-class pest of cotton. Because of a prolonged drought on the South Coast which materially reduced the yield, it is difficult to estimate with certainty the extent of the damage by the pink boll-worm but at least 15 to 20 per cent if not more of the total crop of about 10,000 acres of Sea Island Cotton must have been destroyed. Infestation was noticed in the first cotton to be picked in late December and early January and it grew progressively worse so that not more than one or two pickings could be made from many fields which developed 80, 90 and even 100 per cent infested bolls, often two or three larvae infesting a single boll. The above applies also to the cotton in the Carolina section on the North Coast which, however, was planted at about the same time as that in the South Coast. No cotton was bought after May 15 but it was the end of June before the destruction of the plants was anything like complete.

In the North-Coast cotton-growing section the infestation apparently began to appear early in May or late in April and by the end of May the infestation, tho still light, was apparently general. Since then it gradually increased in severity until by the first of July many fields showed a high percentage of infestation, the damage being fully as great as that suffered by the South-Coast crop. The 1930-crop on the North Coast became fairly generally tho lightly infested towards the end of the crop in the early fall but little loss was occasioned.

About 35 acres of cotton were grown on Vieques Island for the first time in some years; it was harvested in April and May and according to the local Agricultural Agent it was all badly infested, several fields having 100 per cent of the bolls infested and only about one picking was obtained from most of the individual plantings, each of which was small.

The cotton leaf-worm, *Alabama argillacea* Hübner, occurred in destructive outbreaks thruout the year. In the South Coast outbreaks occurred from about mid October (when early plants were large enuf) thru March. None requiring poisoning were reported for April or May altho the leaf worm was present, but especially in the former month a large percentage of the crop had already been picked or was so nearly done that growers would naturally not feel it worth while to use poison even if the insect were present in some numbers. In the North Coast a moderate outbreak occurred near Isabela during March and considerable outbreaks were reported in various places during April, May and June 1931. Considerable poison was used during July and August 1930 in the main part of the North-Coast Section, and in September an outbreak occurred at Canóvanas a little east of San Juan.

According to the local Agricultural Agent on Vieques Island no leaf worm was observed on the approximately 35 acres of cotton growing on the Island during the fall to spring of 1930–31 altho careful watch was kept for an outbreak thruout the growing season.

Stainers, *Dysdercus* spp., have been generally present and often abundant but not usually doing any undue amount of damage, altho there has been some loss from reduction in the quality of the lint. By far the most common species is *D. andreae* L. and altho *D. neglectus* Uhl. is probably frequently associated with it, but one authentic record of its occurrence was obtained. This was at Carolina from April thru June and in this case *neglectus* was apparently the dominent species present in several fields at least.

Blister mite, *Eriophyes gossypii* Banks, has been present on young to old plants in all sections thruout the growing season but not very injurious; occasional plants however are found badly infested and sometimes young plants have been badly dwarfed or even entirely killed.

The black scale, *Saissetia nigra* Neitner, was observed in a number of fields in both the North and South Sections but was not abundant except in one or two cases in the South Coast where a number of old plants were thickly encrusted and apparently considerably weakened by the attack.

The bean lace-bug, *Corythucha gossypii* Fab., was occasionally observed lightly infesting the foliage of a few plants in several places.

A leaf-hopper, *Empoasca* sp. was present in small numbers in many fields examined.

The cotton aphis, *Aphis gossypii* Glov., was present in small numbers in a number of fields.

The cotton leaf-miner, *Nepticula gossypii* Forbes and Leonard, was present, light to abundant, in many fields in the South Coast but like the previous year was not observed in the North Coast.

A scavenger caterpillar, *Pyroderces rileyi* Wlsm., was often observed working in old or decayed cotton bolls.

"Changas", *Scapteriscus vicinus* Scudd., were reported as doing considerable injury to young cotton plants at Isabela in the spring of 1931.

COWPEAS

The cowpea pod and stalk borer, *Fundella cistipennis* Dyar, was repeatedly reared from cowpeas at Río Piedras during the summer and fall.

A bean pod-borer, *Etiella zinckenella* Treit., was several times reared during the summer and fall from cowpea pods at Río Piedras.

The scavenger caterpillar, *Pyroderces rileyi* Wlsm., infesting dry cowpea stems from Vieques Island. Jan. 7. 1931. (A. S. Mills.)

CROTALARIA

The rattlebox moth, *Utethesia ornatrix* L., has been abundant and destructive as usual, at least at the lower elevation, one grower having reported only 7 tons of seed from 60 acres at Bayamón during February and March, which was only about 1/3 normal yield. Another grower at Adjuntas (about 2,000 ft. elevation) reported, however, little damage. The former grower stated that the poorest yields due to activities of the larvae were obtained from seed planted in April, May and June. Since it takes 4–5 months to mature a crop of seed this crop came off in August and September thru October and November and therefore presumably the maximum activity of the larvae would come somewhat in advance of the harvest period.

A bean pod-borer, *Maruca testulalis* Geyer. was found once at Río Piedras in March, a single larva boring within a pod.

A bean pod-borer, *Etiella zinckenella* Treit.. was several times reared from *Crotalaria* pods at Río Piedras during the summer.

A gelechiid pod-borer, *Brachyachma palpigera* Wlsm., was several times found in the dry pods in the late summer and fall from Pueblo Viejo and Bayamón.

A Mycetophagid beetle, *Typhaea fumata* L., (W. S. Fisher det.). was collected—several specimens—in the pods at Pueblo Viejo, Aug. 14, 1930. Not in Wolcott's "List".

CUCUMBER AND MELONS

The melon worm, *Diaphania hyalinata* L., was observed moderately abundant in squash and cucumber at Manatí and in cucumber at Arecibo in January and February and very injurious to melon and cantaloupes near Aguadilla in May.

The melon aphis, *Aphis gossypii* Glov., was present and often injurious in several places but probably was a factor wherever cucurbiits were raised.

A leaf-hopper, *Agallia albidula* Uhler, was common on watermelon vines at Arecibo on Nov. 4, 1930 (Mills and Anderson; P. W. Oman det.). This species has apparently not been definitely before recorded from Porto Rico.

An adult of the weevil, *Lachnopus curvipes* Fab., was found on a watermelon leaf at Arecibo on November 11, 1930 (Mills and Anderson; Buchannan det.) but it probably was not feeding on this plant.

The pickle worm, *Diaphania nitidalis* Stoll, was moderately infesting a patch of cucumbers at Arecibo in March 1931; adults were reared (A. S. Mills).

A leaf beetle, *Diabrotica innuba* Fab., found on the leaves in a watermelon patch at Barceloneta, Dec. 12, 1930 (R. Faxon and A S. Mills; H. S. Barber det.).

EGGPLANT

The leaf-tyer, *Psara perusialis* Walk., moderately infested a fair-sized patch at Río Piedras on Jan. 5 (Anderson and Mills; Heinrich det.). At the Station it was present and troublesome thruout the year.

The eggplant lace-bug, *Corythaica monacha* Stal., was generally present and injurious thruout the year. It was especially noticed as abundant at Palo Seco in August and at Río Piedras, Dorado and Humacao during January and February. The insect was also to be found in greater or less abundance thruout the Island on its favorite wild food plant, *Solanum torvum*.

Fleabeetles, *Epitrix cucumeris* Harr. and *E. parvula* Fab., were more or less abundant in several localities examined, especially during the fall and winter; more damage was done to seedlings than plants in the field.

Aphids, *Myzus persicae* Sulz. and *Aphis gossypii* Glov., were observed in small numbers at Río Piedras, Dorado, Humacao and several other places on the Island during January and February.

Adults of a coreid bug, *Corizus hyalinus* Fab., were collected from eggplant leaves at Caguas, Feb. 18, 1931 (R. Faxon and A. S. Mills; H. G. Barber det.); previously recorded here only from Río Piedras in June, 1916 as "very abundant on weeds in a garden, some feeding on tomato".

Red spiders, *Tetranychus* sp., were abundant and injurious to plants at the Station at Río Piedras during the spring of 1931.

Cut worms, *Noctuidae,* caused about 10 per cent loss of plants in the seed beds grown in the greenhouse at the Station during September and October; they were also injurious in the field to the young plants soon after transplanting.

A leaf-beetle, *Diabrotica graminea* Baly, was more or less injurious at the Station thruout the year, feeding on the flowers and deforming the fruits.

An adult of the egg-plant borer, *Baris torquata* Oliv., was found resting on a bean leaf at Río Piedras on Feb. 14, 1931 (A. S. Mills; L. L. Buchannan det.).

A leaf-hopper, *Cicadellidae,* was generally present throughout the year in small numbers at the Station at Río Piedras but doing little damage.

GRAPE

The brown aphid, *Aphis illinoisensis* Shimer (P. W. Mason det.) was observed lightly infesting a small grape arbor in the Meliá Hotel in Ponce on May 1, 1931 (E. H. Twight of Ins. Expt. Sta.).

GRASSES

The gramma Psara, *Psara phaeopteralis* Guenée, was reported as abundant and injurious near Isabela the latter part of June on St. Augustine grass; about the same time it was very abundant on the some food plant at Aguirre. The adults and larvae were also abundant during June in large patches of a weed, *Gonphrena dispersa* at El Morro in San Juan.

"Changas", *Scapteriscus vicinus* Scudd., did great injury from September 1930 thru February, 1931 to a good-sized lawn near Río Piedras, composed of two mixed grasses locally called "horquetilla", *Chloris radiata* and *C. paraguaiensis* (Pedro Osuna of Ins. Expt. Sta.).

GUAVA

The hemispherical scale, *Saissetia hemispherica* Targ. (H. Morrison det.), was reported as infesting all the fruits on one tree at Juana Díaz, March 13, 1931 (Faxon and Mills).

A West Indian fruit-fly, *Anastrepha* sp. was found breeding in guava fruits during part of the year (see discussion under these two species on page----).

MUNG BEANS *(Phaseolus aureus)*

The leaf-beetle, *Diabrotica graminea* Baly, was numerous on a small patch at the Station at Río Piedras in June, feeding on the blossoms and leaves.

OKRA

The leaf-beetle, *Diabrotica graminea* Baly, was observed moderately infecting a 1-acre planting at Trujillo Alto in March and again in July.

A leaf-hopper, *Cicadalla sirena* Stal., was lightly infesting a ½-acre patch of okra at Trujillo Alto on Mar. 10, 1931 (Anderson and Mills; P. W. Oman det.). This is the first record for okra in Porto Rico.

The hemispherical scale, *Saissetia hemispherica* Targ., was found to be lightly infesting about a 1-acre planting at Trujillo Alto on March 27 (R. Faxon and A. S. Mills; H. Morrison det.).

Aphis gossypii Glov. heavily infested the above patch on the same date (Faxon and Mills; P. W. Mason det.).

The black scale, *Saissetia oleae* Bern. (Morrison det.), was observed lightly infesting the same patch on March 10, 1931 (Anderson and Mills).

ONION

The onion thrips, *Thrips tabaci* Lind., was present as usual wherever onions are grown and often very injurious, more so of course where control measures were not well carried out and in the drier sections and periods.

PALMS

The palm aphid, *Cerataphis lantanae* Boisd., was found badly infesting a plant of *Cyrtopodium Woodfordia* in Santurce on March 4, 1931 (Faxon and Mills; H. Morrison det.).

PAPAYA

The papaya fruit-fly, *Toxotrypana curvicauda* Gerst., had been previously reported only from Mayagüez. A careful survey of many localities in the Island during the end of July and early August failed to discover infested fruits. Early in September however, it was found at Lares and later in the month a number of infested fruits

were found at this town and also in Mayagüez but at no other point in the Island. It was reported again from Lares in January and February. Also 1 out of 7 small green fruits examined in the Mayagüez market on Jan. 6 by Mr. Harley contained 6 larvae. During May and June 1931 many fruits were reported badly infested at one farm near Ponce.

The West Indian peach scale, *Aulacaspis pentagona* Targ., has been observed during the period covered in almost every place in which papayas were observed thruout the Island, often almost entirely encrusting the trunk and branches and many fruits.

Another scale, *Pseudoparlatoria ostreata* Cbll., was observed as very abundant at Ponce and several other places on the South Coast in the fall and also abundant at Isabela in May. It is undoutedly widely distributed and abundant on papaya.

The bean lace-bug, *Corythucha gossypii* Fab., was observed to be scarce to fairly abundant in all stages on the leaves in several widely separated localities during July and August 1930.

PASSIFLORA

Two scale insects, *Pseudoparlatoria ostreata* Ckll., and *Howardia biclavis* Comst. (both Morrison det.), were found to be so heavily infesting eight vines at Río Piedras on July 7 that one vine had died (A. S. Mills).

A few caterpillars of *Dione vanillae* L. were observed eating the leaves of one vine at Río Piedras on July 13 (A. S. Mills).

BLACK-EYE PEA *(Vigna unguiculata)*

The cowpea pod and stalk borer, *Fundella cistipennis* Dyar was reported by E. Molinary and A. Riollano of the Ins. Dept. Agr. to have rendered worthless most of the seed on about 10 acres out of a total planting of about 25 acres at Puerto Real, Vieques Island, in February or March.

PEAS

Specimens of *Blissus leucopterus* var. *insularis* Barber, found on a garden pea plant from Vieques Island, Sept. 10, 1930 (A. S. Mills; H. G. Barber det.).

PEPPERS

A light infestation of corn earworm, *Heliothis obsoleta* Fab., was observed at Río Piedras in January or February. Larvae were also found infesting peppers offered for shipment to the States from Río Piedras in December 1930.

A stink bug, *Arvelius albopunctatus* DeG. lightly infested peppers at Corozal in January or February.

A mealy-bug, *Aleurotrachelus trachoides* (Back.) moderately infested the leaves in a 2-acre planting at Arecibo on Feb. 24, 1931 (Anderson and Mills det. G. B. Merrill).

A Pentatomid bug, *Euschistus crenator* Fab. was observed in all stages feeding on the fruits in a 2-acre planting at Arecibo on Feb. 24, 1930; about 15 per cent of the plants were affected (E. G. Anderson and A. S. Mills; H. G. Barber det.).

An adult of *Nezara viridula* L. was taken feeding on a pepper fruit at Arecibo, Feb. 24, 1931 (E. G. Anderson and A. S. Mills; Barber det.).

PIGEON PEAS

Moths of a bean pod-borer, *Etiella zinckenella* Treit., were several times reared from the pods in a planting near Río Piedras.

Heliothus virescens Fab. larvae were repeatedly found eating large holes into the green pods.

Larvae of a moth, *Brachyacma palpigera* Wlsm., were common during the summer and fall in dry pods and moths were reared from several localities. A proctotrupid parasite of the larvae, *Paralitomastix* n. sp. (Gahan det.) was found in as high as 50 per cent of the larvae in some collections made.

A legume pod-borer, *Fundella cistipennis* Dyar, was found moderately infesting a number of plants during July 1931 at Río Piedras.

A thrips, *Frankliniella (=Euthrips) insularis* Franklin, was found infesting pigeon-pea blossoms at Mayagüez, Jan. 2, 1931 (H. Morrison det.).

The weevil, *Callosobruchus chinensis* L. was found working in dry pigeon-pea pods at Río Piedras, Aug. 8, 1930 (A. S. Mills; H. S. Barber det.).

A Phalacrid beetle, *Olibrus* sp., was commonly found breeding in dry pods at Río Piedras during July and August.

An adult of *Hypothenemus* sp. near *parvus* Hopk. (Blackman det.) was found boring inside a dry pod at Río Piedras, July 15, 1930 (A. S. Mills).

The beetles, *Cathartus rectus* L., *C. advena* Watl. and *C. cassiae* Reiche (W. S. Fisher det.), were all collected from inside dry pigeon-pea pods at Bayamón, July 8, 1930 (A. S. Mills).

PINEAPPLE

The pineapple mealy-bug, *Pseudococcus brevipes* Ckll. (det. Morrison) has been generally present but apparently neither common nor injurious. This according to specimens determined by Dr. Morrison for Dr. Wolcott is not *P. citri* Risso, but is what is listed in Wolcott's "Insectae Portoricensis" p. 281 as P. *bromeliae* Bouché.

The fire ant or "hormiguilla brava", *Solenopsis geminata* Fab., has been generally present and in some cases at least doing some damage.

POTATOES (IRISH & SWEET)

The potato flea-beetle, *Epitrix cucumeris* Harr. was present thruout Jan., Feb. & March and increasing in numbers in several fields of Irish potatoes in Comerío, Adjuntas, Cidra, Caguas, and Río Piedras and especially in March did considerable injury.

The bug, *Spartocera batatas* Fab., injured experimental plots of Irish potatoes at Utuado in March; this is apparently its first record of injury to white potatoes in Porto Rico.

The spinach aphis, *Myzus persicae* Sulz., did considerable injury by the end of March to a small-patch of Irish potatoes near Río Piedras.

A leaf-beetle, *Diabrotica graminea* Baly, was fairly abundant on Irish potatoes at Comerío and Adjuntas early in March and at Cidra early in February.

The potato tuber moth, *Pthorimaea operculella* Zell, lightly infested a quantity of seed potatoes (Irish) which had been received from Prince Edward Island, Canada, and which had been stored under one of the buildings at the Station. The insect had apparently not been recorded as infesting Irish potatoes previously in Porto Rico.

The sweet potato weevil, *Cylas formicarius* Fab., was generally distributed and injurious as is usual, reports especially coming from Humacao, Carolina and Vieques Island.

The Scarabee, *Euscepes batatae* Waterh., was found in May to be heavily infesting some sweet potato tubers in Carolina received for seed purposes from Mayagüez.

The sweet potato leaf-miner, *Agromyza ipomeae* Frost, was apparently present to some extent in practically all parts of the Island but not abundant enuf to be injurious.

Leafhoppers, apparently *Empoasca* sp., were usually observed in fair numbers wherever sweet potato plantings were examined but little injury seems to have been done.

RICE

The "changa", *Scapteriscus vicinus* Scudd., was reported as destroying about 50 per cent of the young plants in a 1-acre field at Juncos during April and into May; 3 acres of rice planted in early April 1930 in the same place were finally entirely destroyed by early July.

ROSE

A mealy-bug, *Orthesia insignis* Douglas, did considerable damage to a number of rose bushes in June in a garden in Santurce.

The cottony cushion scale, *Icerya purchasi* Mask. (Morrison det.), was found lightly infesting 50 rose bushes at Santurce, Feb. 24, (J. Luciano). The first record for Porto Rico.

June beetles, *Phyllophaga* spp., were reported as injuring several rose bushes at Ponce in early May by damaging the roots while burrowing for the purpose of egg-laying.

A leaf beetle, *Metachroma antennalis* Weise, was reported as doing very considerable damage to roses at Aguirre from April on; the beetles were present in enormous numbers, eating the flowers, leaves, and bark and over 400 out of about 1,000 bushes were practically destroyed.

SUGAR CANE

The sugar-cane moth-borer, *Diatraea saccharalis* Fab., did apparently the usual amount of damage which as probably, as far as could be determined, about the same as during the previous year or two. One large Central, however, near Hormigueros at the West end of the Island, reported a very high percentage of infested cane in many fields and stated that borer was worse than during the two years previous. As usual the percentage of cane infested was somewhat higher on the South Coast than in those parts of the North Coast having a higher rainfall. This statement is based upon many canes examined in several places during the harvest period from February to May 1931. At Aguirre and one or two other localities a rather high percentage of eggs were found infested with *Trichogramma minutum* Riley, but only a few eggs masses altogether were examined. Evidences of some parasitism by *Lixophaga diatreae* Towns. were also observed in almost every locality in which cane was examined, but no counts were made to determine percentages.

White grubs, *Phyllaphaga* spp., did about the usual amount of moderate damage. Altho the adults may not have been noticeably much less numerous than during the previous year or two it is the opinion of several of the larger sugar companies that white grubs

are less injurious now than previously. The manager of a large Central near Aguadilla felt that the damage had been less this past year due to the imported toad, *Bufo marinus* L., eating the adults. Surveys in a number of cane fields in different parts of the Island showed that these toads eat large numbers of June beetles and several large cane growers feel that they have been noticeably beneficial in white grub control. The adults were scarce at lights at Aguirre early in June and entirely absent late in the month.

The "vaquita", *Diaprepes spengleri* L., caused some stripping of young cane leaves as usual; one rather severe case of this was observed in Isabela but the young cane recovered due to abundant rains following the injury.

The yellow cane aphis, *Sipha flava* Forbes, caused very considerable damage in the western end of the Island from Isabela, Moca and Aguada to Cabo Rojo, Lajas, and Guánica. This started in December and gradually increased in severity thru March but during April, abundant rains following the pronounced dry spell, the infestation ceased. Not only Japanese cane but also POJ–2725 and 2878 were affected. At Aguada in March *Cycloneda sanguinea* L. was common in infested fields but the pupae were highly infested by an undetermined Chalcid. Altho the extensive properties of the Aguirre Sugar Co. on the South Coast suffered a considerable dry spell during the winter, Mr. Herbert Osborne Jr. and others reported the aphis not as bad as during the previous year.

The sugar-cane root-caterpillar, *Perforadix sacchari* Seín, was probably present in about the usual numbers. Moths were abundantly observed in one field near Mayagüez in April among the cane on the ground just after cutting.

The sugar-cane scale, *Aspidiotus sacchari* Ckll., was generally distributed thruout variety experimental plots examined during April and May at Mayagüez, Naguabo and Guayama, the percentage of cane infested at Mayagüez being small but in the other two places about 10–12 per cent.

The pink leaf-sheath bug, *Lasiochilus divisus* Champ., was found fairly commonly and in all stages in a large experimental plot of several cane varieties examined in April near Mayagüez. Early in June adults were fairly common at light at Aguirre but late in the month were scarce.

The West Indian cane weevil, *Metamasius hemipterus* L., was probably generally present but was observed (in cane being harvested) only at Mayagüez (light infestation) in April and fairly common at Guayama.

The sugar-cane mealy bug, *Pseudoccoccus sacchari* Ckll., was observed more or less commonly at harvest time (February–May) in several localities on the North and South Coast and West end of the Island, but was apparently somewhat more common in the south.

The red-striped sugar-cane scale, *Pulvinaria iceryi* Guer., was found infesting the leaves of some sugar-cane plants in one of the greenhouses at the Station at Río Piedras in March.

The adults of the Scarabeid beetle, *Dyscinetus barbatus* Fab., known to attack sugar cane, were abundant at lights at Isabela for a few weeks, being first noticed about the middle of April, but became scarce the middle of May and soon after failed to appear any more.

A leaf-hopper, *Protalebra brasiliensis* De Long, listed as a minor pest of sugar cane in Porto Rico, was abundant thruout June on large patches of a weed, "margarita" or "clavelillo" (*Bidens pilosa*) on the golf course at San Juan but was scarce at the Station at Río Piedras.

The Scarabeid beetles, *Ligyrus tumulosus* Burm., were common at light early in June at Aguirre but scarce the end of the month.

SWORD BEAN (*Cannavallia* sp.)

The cowpea pod and stalk borer, *Fundella cistipennis* Dyar, was reported as moderately infesting the pods in a patch at Florida during the latter part of April.

TOBACCO

The tobacco leaf-miner, *Phthorimaea operculella* Zell., did considerable damage, more so than usual due to unusually dry weather, around Comerío and Caguas, and also in one field near Río Piedras during February, March and April.

The tobacco hornworm, *Protoparce sexta* Joh. var. *jamaicensis* Butler, was undoubtedly generally present as usual; it was reported specifically as having completely stripped the leaves from a 2-acre planting at Juncos during April; no attempt at control had been made.

The "changa", *Scapteriscus vicinus* Scudder, was generally present and more or less injurious. In the Juncos–Las Piedras tobacco section it was reported as killing about 15 per cent of the young plants in the field during November and December which is said to be about the usual amount of damage there.

Climbing cutworms, *Noctuidae*, were reported as more injurious

than usual to young plants in the Juncos–Las Piedras section, killing about 20 per cent during November and December.

Flea-beetles, *Epitrix cucumeris* Harr. and *E. parvula* Fab., were very injurious to seed-beds at the Station in September and October but present and injurious also to plants in the field during the winter. They were also generally distributed and injurious throughout the growing season (winter and spring) in the tobacco sections. Damage was reported as light during the winter to seedbeds in the Juncos–Las Piedras district. Early in May some damage was just starting to late tobacco in the field around Humacao.

TOMATO

The corn earworm, *Heliothis obsolete* Fab., was observed moderately injuring tomato fruits during January or February at both Río Piedras and Arecibo.

A plant-bug, *Phthia picta* Drury, was present in all stages and puncturing about 50 per cent of the fruits in a small patch of tomatoes at Río Piedras in January or February. A single plant at the Demonstration Farm at Mayagüez had all stages present in abundance in April, but little damage had been done.

Nezara viridula L. was observed injuring about 20 per cent of the fruits in the same garden patch at Río Piedras in December (A. S. Mills).

An adult of the bug, *Thyantor perditor* Fab., was found feeding on tomato fruit at Corozal Feb. 5, 1931 (A. S. Mills; H. G. Barber det.).

Cutworms, *Noctuidae,* caused about 10 per cent loss to plants in seed-beds in greenhouses at the Station in September and October and about 20 per cent to young plants after being set in the field.

The leaf-tyer, *Pachyzancla perusialis* Walk, was present in the field but more injurious to a number of experimental plants grown in the greenhouse thruout the year.

The potato and tomato flea-beetle, *Epitrix cucumeris* Harr., was generally present and sometimes doing considerable injury.

"Changas", *Scapteriscus vicinus* Scudd., were reported as doing considerable injury to young tomato plants at Isabela.

WEST INDIAN LAUREL *(Ficus nitida)*

The mealy-bug, *Icerya montserratensis* Riley and Howard, was observed badly infesting one or two of a number of large trees in the Plaza at Caguas in April. It was probably present during the

year since several subsequent examinations showed it to be about the same.

A thrips, *Gynaikothrips uzely* Zimm = «*Mesothrips ficorum* Marchal» was observed abundant as usual in several parts of the Island, often considerably curling the leaves.

WEST INDIAN FRUIT FLIES

One species of *Anastrepha* was generally distributed and as abundant as usual. The jobo or hog plum, *Spondias mombin*, is its most favored host and is always found infested from June to December, the period of ripe fruits. Ciruelas, *Spondias cirouella* and *S. purpurea*, were also commonly infested during their fruiting season, August thru October, but not quite so heavily. Certain varieties of native and imported mangos were commonly infested from April thru June; certain other varieties, heretofore always reputed to be immune, have remained so, as far as observations could determine. It also breeds to some extent in guavas.

Another species has been found breeding commonly in pomarrosa, *Jambos Jambos*, during April and May, apparently being its favorite foodplant. Bitter almond, *Terminalia cattapa*, was also found infested during April thru August 1931 but only in a comparatively few fruits at Río Piedras and Arecibo. This is commonly found in guavas. (F. Seín, Jr.)

MISCELLANEOUS RECORDS

The following records are from interceptions made by the United States Plant Quarantine and Control Administration office in San Juan during the fiscal year. Altho not primarily of economic importance they constitute in most cases new or interesting records for the Island:

A scale, *Conchaspis angraeci* Ckll. (Morrison det.), heavily infesting the branches of an undetermined tree at Río Piedras, July 7, 1930 (A. S. Mills). Listed previously only on vanilla at Mayagüez (1917) and ornamental croton at Mameyes (1912).

A predacens bug, *Coreocoris fusca* Thunberg (H. G. Barber det.) adults and nymphal instars on a weed, Bayamón, Aug. 8, 1930 (A. S. Mills). Not in Wolcott's "List".

Several adults of a Cynipid, *Eucoila (Hexamerocera) hookeri* (L. H. Weld det.) were reared from jobo fruits infested with *Anastrepha* sp. at Mayagüez, Sept. 21, 1930 (A. G. Harley). Not in Wolcott's "List".

An adult of *Opius anastrephae* Vier. (A. B. Gahan det.) also reared from jobo, *Spondias lutea*, as above.

An ant, *Tapinome littorale* Wheeler (W. M. Mann det.) in dry leaves at Aguas Buenas near the mouth of the caves, Oct. 1930 (A. S. Mills).

An Anthomyid fly, *Atherigona excisa* Thomson (Aldrich det.) reared from larvae in decayed areas in string-bean pods from Isabela, collected Sept. 20, 1930 (Faxon and Mills); also reared from 7 larvae in tomatoes for export, Borinquen (near Aguadilla) Jan. 12, 1931. Not in either Wolcott's or Curran's "Lists".

The vinegar fly, *Drosophila ampelophila* L. (C. T. Green det.) reared in numbers from string bean pods as above; also 3 adults on a banana leaf Maricao, Dec. 11, 1930 (A. G. Harley). Not previously reported from Porto Rico.

The Nitidulid beetles, *Stelidota geminata* Say and *Scymnillodes gilvifrons* Chpn. (E. A. Chapin det.). were found in a decayed area in an orange at Barceloneta, Dec. 12, 1930 (Faxon and Mills). The former is little known in Porto Rico and the latter is not in Wolcott's "List".

Nitidulid *Haptonchus luteolus* Er. (Chapin det.), adults were found in decayed fruits of *Inga laurina* at Santurce, Dec. 19, 1930 (E. G. Anderson and A. S. Mills).

A large nymph of an earwig, *Anisolabis annulipes* Lucas (A. N. Caudell det.) was taken in the above fruits also.

An Ortalid fly, *Euxesta stigmatias* Loew. (Aldrich det.) was reared from an ear of corn Sept. 12, 1930 from Río Piedras (A. S. Mills). The locality is new for Porto Rico.

A Reduvid bug, *Zelus longipes* L. (H. S. Barber det.) collected on a pepper leaf Nov. 4, 1930, at Arecibo (A. S. Mills).

A Trypetid fly, *Xanthaciura phoenicura* (Aldrich det.) on a grapefruit leaf at Añasco, Nov. 5, 1930 (A. G. Harley). Not previously reported from Porto Rico.

A Coreid bug, *Chariesterus gracilicornis* Stal (H. G. Barber det.) found resting on a grapefruit leaf at Añasco Nov. 5, 1930 (A. G. Harley).

A Calliphorid fly, *Morellia violacea* Fab. (Aldrich det.), 3 adults collected from orange foliage, Maricao, Dec. 18, 1930 (A. G. Harley). Not previously reported from Porto Rico.

A Trypetid fly, *Euaresta melanogaster* Lw. (Aldrich det.) swept from grass in an orange grove, Maricao, Dec. 26, 1930 (A. G. Harley). Little known in Porto Rico.

A Psocid, *Embidopsocus lutens* Hagen (Caudell det.). Numerous

adults and nymphs in cereal in a glass jar, San Juan, Dec. 25, 1930 (Faxon and Mills).

An adult of the butterfly, *Lycaena cassius* Cramer (Shaus det.) on a bean leaf, Manatí, Jan. 16, 1931 (Anderson and Mills). Recorded only once, from Camuy.

An earwig, *Psalis americana* var. *gagathina* Burm. (Caudell det.), 1 female in decayed trunk of banana, Maricao, Jan. 24, 1931 (Harley, Faxon and Mills). A new locality record.

A Nitidulid beetle, *Lobiopa insularis* Cast. (Böving det.) young larvae in jobo fruits, Río Piedras, Jan. 26, 1931 (Faxon and Mills).

A Stratiomyd fly, *Neorondania chalybea* Weid. (C. T. Greene det.) taken on a potato leaf, Cidra, Feb. 18, 1931 (Faxon and Mills). Previously listed only from Río Piedras.

A Coccinellid beetle, *Cycloneda limbifer* Csy. (E. A. Chapin det.), adult on eggplant, Caguas, Feb. 13, 1931 (Faxon and Mills). Not listed previously from Porto Rico.

A Coccinellid, *Neda ferruginea* Oliv. (E. A. Chapin det.), adult on cotton leaf, Ponce, Mar. 13, 1931. (Faxon and Mills).

A Coccinellid, *Scymnus loewii* Muls. (E. A. Chapin det.), several adults in a box of peppers from Vega Baja, Mar. 7, 1931 (Faxon and Mills).

A NEW FROG FROM PUERTO RICO

CHAPMAN GRANT, Major, United States Army.

My collection of over 6,000 specimens collected in nineteen months in and near Puerto Rico contains 21 species or subspecies and one genus not listed in the last herpetology of this Island. The present is the most elusive species discovered. It may be called:

Eleutherodactylus cooki sp. nov.

Type—From Pandura Mountains, Southeastern Puerto Rico, collected by Chapman Grant, January 24, 1932. Chapman Grant collection. No. 4108, adult.

Range—Known only from type locality

Diagnosis—Distinguished from the other salentia of Puerto Rico by having vent to heel as long as vent to snout; toe discs twice as wide as long and plain brown back. Thighs and venter only slightly and finely rugose. Eyes very large. Throat sometimes canary yellow. Voice distinct. Life history distinct.

Description of type—Habitus slender, head wider than body, eyes large and protruding; limbs weak, relatively long, heels widely overlapping when thighs are placed at right angles to body; heel reaches snout when extended forward. Vomerine teeth in slightly curved oblique series, behind and within the choanae, the distance between series about half the length of one series. Tongue large, oval, notched behind. Nostrils near tip of snout, prominent. Tympanum distinct, its width slightly less than half the width of eye.

Eye very large, width equal to eye to tip of snout, appears black but when a living specimen is examined in sunlight the iris is black, finely reticulated with gold. The edge of the eyelid is white, making a narrow white line around the eye. The eye protrudes so far that the impression of mouse ears is given. Unfortunately, the eyes shrink somewhat in alcohol. The four fingers free with discs twice as wide as long; tubercles prominent, the five toes free with similar discs. Skin smooth below except for slightly rugose venter, lower surface of thighs slightly rugose; above smooth except for a few scattered excrescences or warts. Color in life, light brown above, darker at head, legs lighter, underside nearly white, but minutely and evenly specked with dark. No markings.

Measurements—Snout to vent 37 mm.; vent to heel 37 mm.; width

of head 15 mm.; snout to posterior edge of tympanum 14 mm.; leg from vent 60 mm.; foreleg from axilla 26 mm.; tibia 18 mm.; hind foot 23 mm.

Voice—Four more specimens were taken alive February 28th and fourteen more on March 27th. They were kept separate to hear a "pure culture" vocalization. *E. richmondi* occurs in small numbers in the same locality, so it was thought important to check positively on the song. The four specimens were kept separate over night and sang. There is not the slightest resemblance to the voice of any of the other *Eleutherodactyls* of Puerto Rico. One adult was seen in the act of singing. The body was raised on front feet at a forty-five degree angle, hindquarters on a boulder, throat distended and vibrating. The note is repeated six or seven times and cannot be reproduced by a syllable or on the piano. The nearest is pe-pe-pe-pe-pe-pe pe. one-sixteenth notes in second A treble. The note has a liquid sound and can best be imitated by whistling.

On March 27, fourteen specimens were taken. Although the weather conditions were similar to February 28th as to dryness, the temperature was probably slightly higher. The amount of singing had greatly increased, probably due to breeding. More frogs were seen in the "open", i.e., on the perpendicular faces of the rocks, and fewer hidden in cracks. The yellow throats prodominated. Probably they were the males, singing and in search of females.

Aside from an entirely different voice, this species differs from *E. portoricensis* in the following details:

	E. portoricensis	*E. cooki*
Heel to vent	less than vent to snout	equal or longer than vent to snout
Rugosity of belly and thighs	coarse	fine
Digit pads	slightly wider than long	over twice as wide as long
Width of ear	over half width of eye	less than half width of eye
Width of eye	less than eye to snout. Appears normal	equals eye to snout. So large as to resemble mouse ears.
Iris	lighter above pupil. Brassy	all same color, appearing black
Back	variously colored or marked	one color, no markings
Throat	never bright yellow	sometimes bright yellow
Habitat	above ground	deep caves
Song	co-qui' (accented)	pe-pe-pe-pe-pe-(melodious)
Underside	dark	nearly white

Life history:

An eyed egg is 6 mm. in diameter; uneyed, from 4 mm. up. They are covered with a thin layer of viscous gelatin and pasted together in a single layer in a clump of about twenty-five on the perpendicular face of a damp rough boulder in the semi-darkness of the chasms. When lifting the eggs from the granite, by getting hold of two or three, the whole clutch may peel off as a unit. At each clutch seen, a frog was sitting next to the eggs, facing away from them.

Two clutches of *E. cooki* eggs were allowed to hatch in a vial containing a rag kept wet for moisture. A similar vial contained *E. portoricensis* eggs. Upon hatching, *E. portoricensis* measured 6 mm. snout to vent and *E. cooki* measured over 8 mm. Newly hatched *E. portoricensis* is dark brown with scattered white dots, larger and fewer above and numerous and small below. Newly hatched *E. cooki* is much larger, light olive with complicated dorsal markings of darker brown; rings around fore and hind legs, wide band joining eyes, etc.

Variation: About half of the specimens have canary yellow on the throat, some have solid yellow or yellow blotches, the others light brown. Unfortunately, the yellow fades in twelve hours in alcohol. In smaller specimens, the yellow is in patches. On large specimens, the throat and extending back to just behind the front legs is a clear canary yellow. The only sign of pattern above is a faint light band joining the eyes, seen only at certain times. Some of the largest males (?) have yellow on the sides, where the thighs usually cover, and yellow tinges on the thighs. The white ring around the eye is very noticeable in living specimens. The eye is black and gold and the same color above as below the horizontal pupil. The nictitating membrane closes from the rear forward and completely covers the eye at will.

Remarks—There was an infestation of small red ticks on the legs and sides of these frogs.

This is the most romantic species on the Island. It inhabits the "guajonales" of the Pandura Mountains, and is known locally as a "guajone". A "guajonal" is a place where wild bamboo grows, but here used to designate a mountain gorge tumbled full of granite boulders from bungalow to grand piano size. One can hear from the surface a most melodious note coming from the depths, a sweet liquid pe-pe-pe-pe-pe-pe-pe resounds from the gloomy caves, echoes, re-echoes and is repeated by other "guajones". "The 'guajone' is only a voice. No one has ever seen one", the natives say. In the day time, with

a flash light, one can crawl down one, two, three tiers of jumbled boulders to the hidden stream bed in disintegrating granite. The "guajones" sing, but it is impossible to locate them by ear. The flash-light and a slender twig will serve to locate and dislodge them from deep cracks less than half an inch wide under the husks of exfoliating granite, or from the damp earth where earth and boulder meet. It took me three all-day trips to secure one specimen. It was only on the third trip that I discovered their hiding places and then several escaped after being pried out. One might as well try to bribe a mountaineer to catch a ghost as a "guajone". I tried it; money is no object.

The frog is a poor swimmer. It does not go into water of its own accord. When placed in water, it gets out as quickly as it can. Its movements in water are in contrast to its agility on boulders.

Specimens taken—19.

Named in honor of Dr. Melville T. Cook

NOTE: Since going to press the number of specimens taken has increased to 66; some measuring as much as 54 mm. snout to vent.

THE GENUS ALSOPHIS IN THE PUERTO RICO AREA

CHAPMAN GRANT, Major, United States Army.

The genus *Alsophis* splits into two distinct species in the Puerto Rico region. The first has seventeen scale rows, at mid-body, and is known only from Puerto Rico, Caja de Muertos, Desecheo and Mona Islands. The second, with nineteen rows, is known only from the Virgin Islands, Culebra and Pinero Islands. Pinero is less than a half mile from Medio Mundo Island, which in turn is separated only by a narrower channel from Puerto Rico. One would expect to find *A. portoricensis* instead of *A antillensis* so close to the mainland and so far from Culebra or Vieques. This is another anomaly of distribution.

Stejneger and Schmidt lay emphasis on pattern in distinguishing the species of this genus. Schmidt split the Mona from the Puerto Rican form principally because of pattern. One can pick an almost typical form of any of these patterns from my series from any island; that is, the patterns overlap—are not wholly specific. Nevertheless, the patterns shown by Stejneger and Schmidt hold in the majority of cases from Mona, but specimens from Caja de Muertos average between the Mona, the Puerto Rico and the Culebra patterns.

Specimens from Culebra are reticulated above with clear white bellies; one with a continuous stripe on third, fourth, and fifth rows and with black bordered belly scales. These overlap the pattern of *A. portoricensis.* An *A. portoricensis* shows hardly any black on the belly, but with elaborate striping and variegated markings, thus at once bridging all three species. Caja de Muertos specimens show nearly perfect patterns of the three species. The Pinero specimens seemed at first to be slightly aberrant *A. portoricensis*, but they were *A. antillensis.*

Nevertheless, my quart bottles full of specimens can be sorted correctly using Stejneger & Schmidt's text figures for a guide, except for the Caja de Muertos specimens, which are about equally divided between the three patterns. It seems wise to indorse the division as it now stands, but *A. variegatus* is very close indeed to *A. portoricensis.* A large series from Desecheo Island, which lies between Mona and Puerto Rico, would be interesting. Schmidt was hardly warranted in attributing *A. antillensis* to Puerto Rico on the strength of two specimens, one having seventeen rows.

Schmidt (p. 141) states: "The identification of the two specimens collected by me at Coamo Springs as this species (*A. antillensis*) removes the element of geographical distinctness from the allied *A. portoricensis*. The male specimen has only seventeen scale rows and so might be identified with *A. portoricensis,* were it not that the coloration of both specimens is nearly typical of *A. antillensis.*" The species do seem to be geographically distinct. This opinion is based on eighty-four specimens, all in my collection. It will be noted that in the "table", characters considered specific by other writers have been omitted. A study of my series makes this necessary, as no color or pattern is wholly specific. Without correct geographical data, it would be difficult to classify correctly all specimens.

As stated above, Culebra specimens have "clear white bellies" in alcohol. In life the chin and the anterior third or less of the belly is a bright straw yellow. This color was not seen in this species from other islands.

Table showing the specific characters selected by different writers	Seventeen scale rows at midbody				Nineteen rows at midbody	
	A. variegatus		*A. portoricensis*		*A. antillensis*	
	Specimens	Characters	Specimens	Characters	Specimens	Characters
Stejneger "The Herpetology of Porto Rico" U. S. N. M. 1904	38 specimens from Mona studied but attributed to *portoricensis* None in U. S. N. M. collection		38 Mona 1 Desecheo 4 Porto Rico (Only 3 in U. S. N.M collection)	No distinctive color on 5th scale row	5 Culebra 3 Vieques 22 St Thomas 4 Virgin Ids. (Only 7 in U. S. N. M. collection)	Every 2nd or 3rd scale of 5th row particolored
Schmidt Scientific Survey N. Y. Acad. Sci. 1928	3 Mona	No reticulation. No black border to ventrals. Reduces to 15 rows.	5 Porto Rico and Caja de Muertos and "notes on 13"	Reticulated. Black border Reduces on ventrals to 13 or 14 and rarely 15 rows	None	Row of black spots on 5th row
Grant The entire series of 82 is in the Grant collection	28 Mona	Usually variegated Mona	8 Porto Rico 4 Caja de Muertos	Usually reticulated Porto Rico and Caja de Muertos	35 Culebra 7 Pinero 2 Dog Island	Usually specked. Culebra and Pinero

A REDESCRIPTION OF *AMPHISBAENA CAECA* WITH A DISCUSSION OF ITS RELATIONSHIP TO *A. BAKERI*

CHAPMAN GRANT, Major, United States Army.

Stejneger, 1904, redescribed *A. caeca*, using a series of 19. Schmidt, 1928, studied a series of 18 and quotes Stejneger verbatim. In my series of 100, I find a sufficient difference from the description to make it worthwhile to rewrite.

The blind legless lizard of Puerto Rico is well known to the country people who turn it up with the plow or find it under stones or logs. They fancy it bears a strong resemblance to an earth worm or the blind snake, *Typhlops*. The generic name *Amphisbaena* comes from the Greek, meaning a snake able to move in either direction. The specific name *caeca* means blind.

The species was described by Cuvier in 1829.

Type locality: Not known.

Distribution: Confined to Puerto Rico where it had been recorded from Aibonito, Bayamón, Catalina Plantation, Lares, Luquillo, Mayagüez, Río Piedras and Utuado. I have taken it in addition at Humacao, Maricao, Cialitos and Juana Diaz, thus considerably increasing its known range.

Diagnosis: An Amphisbaena with 225–235 body rings, usually one temporal scute, 18 or 19 rings on tail.

Squamation based on 100 specimens:

Rostral small, triangular, the portion visible above short, about equalling the suture between the nasals; prefrontals long, suture generally longer than suture between frontals. If not measured prefrontal suture looks much longer due to an optical illusion. Suture between prefrontals or frontals about four to five times as long as the nasal suture: ocular moderate, quadrangular, smaller than either the postocular or the third supralabial. A well developed quadrangular or roughly triangular temporal between and behind the latter two and slightly smaller than the ocular. Eye faintly visible through ocular. A pair of occipitals, broader than long, more often in contact than separated behind the frontals. Three supralabials, the second as long as the other two together. Three lower labials, the second longer than the other two together. Mental followed by a single (50 per cent) or longitudinally creased (40 per cent) or a pair (10 per cent) of post mentals, followed invariably by three postgeneials,

followed by four, rarely three, (7 per cent) scales of the first body ring. Below the second and third lower labials, a large malar shield; usually (85 per cent) from 225 to 235 rings on the body and 18 or 19 on the tail. At about the 100th body ring 16 (rarely 14 or 18) rows above the lateral line and 18 (rarely 16 or 20) below. Usually (66 per cent) 2 more rows below lateral line than above, sometimes (33 per cent) equal, but never more above than below. The segments of each ring longer than broad on the back, broader than long on the under side. The two abdominal rows distinctly flat and broad. Anal shields usually and normally 6; preanal pores normally 4. Color: flesh color, with a squarish brown spot, darkest on the back, occupying the middle of each segment, these spots being usually (80 per cent) absent on many of the ventral segments on the posterior half of the body and frequently (50 per cent) absent on the throat in a small spot leaving these areas light flesh color.

When the brown spots are not absent, the underside is a uniform color (20 per cent). I must take exception to Stejneger "... a large median postmental, twice as long as broad". In my specimens, I find it 1½ to 1⅓. Apparently more nearly quadrangular than in *A. bakeri*, judging from the Fig. 136.

Remarks: Stejneger, 1904, Figs. 128, 130 are unusual in that they show a decidedly rectangular temporal. Only very rarely is the temporal in the form of an elongated triangle, the point reaching the angle of the mouth as shown in Stejneger, Fig. 132. This is caused by the fusing of the temporal with a body ring scale. I have specimens with these scales fused on one side only, the other side being normal. The most frequent form of temporal seen is two sharp angles and a rounded end. Stejneger Figs. 128, 130, copied by Schmidt, 1928, Fig. 36, shows four lower labials, but their descriptions do not mention the occurrence of four. I have but one specimen with four lower labials. Stejneger Figs. 127, 129 shows the nasal suture contained 4 and 5 times respectively in the prefrontal suture instead of "... one-fifth or less". I find it 4½ and rarely 5 times. This tends to lessen the difference between it and the squamation of *A. bakeri*.

Stejneger shows 5 scales following the 3 postgenials in *A. bakeri*. A letter from Miss Cochran states that two of their three specimens have these 5 scales. In my specimens of *A. caeca* from the eastern third of the Island, the uniform 3 postgenials are followed by 4 scales or by 3 in 3 cases. This constitutes an important distinction between *A. bakeri* and *A. caeca* and would tend to show variation away from *A. bakeri*.

Two specimens taken from the vicinity of Juana Díaz are remark-

able in having a low number of scales around the body, namely 14 above the lateral line and 14 and 16 respectively below it and 230 and 226 body rings respectively. The number of rings is average for *caeca,* but less than *A. bakeri;* the low number of scales is divergent from either species. One specimen has five scales following the postgenial which ties it to *A. bakeri,* and one lacks a temporal on one side—a specific point of *A. bakeri.* My opinion is that *caeca* runs truer to form on the eastern part of the island and varies on the western. The specific validity of *A. bakeri* seems dubious.

THE LARGE AMEIVAS OF THE PUERTO RICO REGION WITH ONE NEW SPECIES

CHAPMAN GRANT, Major, United States Army.

The *Ameivas* of Puerto Rico and the adjacent islands and keys have a general superficial resemblance. The fact that most species are hatched with definite markings which change greatly with growth, going through several phases or combinations of colors and markings, makes it necessary to have fairly large series to determine specific values. Evidently earlier writers have not had sufficient series or the following interesting facts would have come to their attention.

Beginning on Mona, there is a gray species, *A. alboguttata,* which retains its small dorsal dots through life and has a low number of femoral pores and indistinct or no dorsolateral lines, which if present begin at the neck. Next east lies Puerto Rico, with a brown species, *A. exsul,* which loses its dorsal dots with age, has a higher number of femoral pores and distinct dorsolateral white lines beginning at the eye. This line fades or disappears with age. On Diablo Island, or key, further to the east, there is a black species with bright blue ventral coloration and side marking, *A. birdorum,* which retains its large dorsal dots through life and has a low number of femoral pores like the form on Mona. Its dorsolateral white lines fade or disappear early in life. There are other constant and minor differences which the following tables help to bring out:

	Number of femoral pores expressed in per cent								
Number of pores	11	12	13	14	15	16	17	18	
A. alboguttata	1	10	37	38	14	0	0	0	%
A. birdorum	0	18	21	31	27	1	0	0	%
A. exsul	0	1	5	17	29	28	12	5	%

The above table separates the Mona and Diablo forms into one group of low pore counts, contrasted with the Puerto Rico form, with a high pore count. The same table expressed in numbers of femora bearing a specified number of pores brings out the same fact.

Number of pores	Number of legs having 11 to 19 pores								
	11	12	13	14	15	16	17	18	19
A. alboguttata—legs 117...	2	12	44	45	14	0	0	0	0
A. birdorum—legs 80.....	0	15	17	25	22	1	0	0	0
A. exsul—legs 310. . ..	0	3	15	46	88	86	49	21	4

The following table brings out specific color and pattern differences and serves better than a key.

Ameiva	*A alboguttata*	*A. birdorum*	*A. exsul*
Dorsolateral lines begin at	Shoulder.	Ear	eye
Dorsolateral lines sometimes absent in young	Yes .	No..	No
Dorsolateral lines clearcut in young	No... .	Yes	Yes
General color of back	Gray . . .	Black	Brown
Dorsal dots persist through life..	Yes .	Yes	No
Dorsal dots begin at.	Neck .	Shoulder..	Shoulder
Size of dorsal dots	Small..	Large . . .	Very small
Median light band present	Seldom....	No.	Yes
Median light band if present commences at	Shoulder .	No	Head
Black bands central to dorsolateral lines present at least in young	No.. . .	Entire back black	Yes
Black bands lateral to dorsolateral lines usually continuous to middle age....	Yes. . .	Yes.	No
Black bands lateral to dorsolateral lines break in to widely separated rhombs in adults	No..	No.	Yes
Lateral dots tend to form vertical stripes	No.	Yes........	Yes
White line axilla to groin occasional	Yes	No	Yes
Color of underside...	White or light blue	Dark blue...	White or light blue
Color of chin of large specimens........	Red......... .	Purple.... .	Lavendar
Usual number of anal plates..	5	3	3
Average number of femoral pores..	13.2	13.8..	15.3

Stejneger (1904) gives an excellent description of *A. exsul* and *A. alboguttata.* His pore counts tabulated are as follows, according to percentages:

Pores	12	13	14	15	16	17	18
A. alboguttata, 16 sp..................		81		19	0	0	0
A. exsul, 67 sp......................	5	1	12	37	27	12	6

This is interesting as it gives practically an identical distribution found in my larger series. He states, "The main differences (between *A. exsul* and *A. alboguttata*) seems to be one of coloration". He gives a minute color description but his series from Mona was not sufficient for him to detect specific differences in markings. He points out that *A. alboguttata* has five anal plates but his material was not sufficient for him to speak with finality.

Schmidt (1928) states: "*A. alboguttata* is extremely close to *A. exsul,* but may be distinguished by the more spotted dorsum. The femoral pores in 40 specimens average 13.2, in 40 *A. exsul,* the average is 15.3. . . ."

His figure, "35 *A. alboguttata* A.M.N.H. 14003", is misleading. In fact, it could be identified as a specimen of *A. exsul*. In my 60 specimens of *A. alboguttata*, not one has the dorsolateral line beginning on the superciliary ridge or has these lines clear-cut. Not one has a median light stripe showing on the neck, and extremely few have any indication of a light stripe, even on the back. Not one has the same color below as above the dorsolateral line. All have black below it. These features in his illustration are all specifically absent in *A. alboguttata* and specifically present in other species, except the absence of the black line below the dorsolateral white line, which is present in all of my total series of 341 specimens of this group of the genus taken from some of the Virgin Islands and keys as well as the Puerto Rico region.

Consolidating the averages of the pore counts, we have:

	A. alboguttata		*A. exsul*		*A. birdorum*	
Stejneger. .	16 sp	13 3	67 sp.	15 4		... .
Schmidt. .	40 sp.	13 2	40 sp	15 3		....
Grant	60 sp.	13.3	157 sp.	15.3	43 sp.	13.8
Total	116 sp.	13 2	264 sp	15 3	43 sp.	13.8

Barbour, in Zoologica, 1930, Vol. XI No. 4, p. 102, gives the distribution of *A. exsul* as follows: "St. Thomas, Water Island, St. John, Vieques, Anguilla, St. Croix, and Puerto Rico. Now exterminated on St. Thomas. I have always doubted the St. Croiz record." To this list may be added: all islets around Puerto Rico and Culebra. It is very scarce on Vieques. In the Virgin Islands: Numerous on St. Thomas; strangely not seen on Buck Island of St. Thomas, or on St. Croix or Buck Island of St. Croix; on St. John taken only at Crum Bay; taken on St. James and Little St. James, but not seen on Dog Island, or Congo Key. Taken on Lovango key. West records it on St. Croix in 1793.

Ameiva birdorum, sp. nov.

Type:—From Diablo key off Fajardo, Puerto Rico, collected by Chapman Grant, January 21, 1932. Chapman Grant collection, No. 4073, adult.

Range:—Known only from type locality. Diablo key is only about ten acres in extent.

Diagnosis:—Distinguished from other *Ameivas* of the Puerto Rico region by its black back, blue undersides and low femoral pore count, averaging 13.8.

Description of Type:—Squamation similar to *A. alboguttata,* almost black above, save neck and shoulders, which are deep olive brown; spotted coarsely from behind shoulders nearly to end of tail with yellowish spots covering about 20 granules. Forelegs black, hind legs black, spotted with yellow and blue. No trace of dorsolateral lines. Sides jet black sparsely spotted with coarse blue dots, spaced in vertical rows as continuation of about every third row of abdominal scales. Underside: Chin purple, creases of neck flesh color; chest and 4 central rows of abdominal scales clear blue, thence laterally alternating black and blue. Vent and stripe on ventral side of fore and hind legs flesh color. Tail like belly but deep blue. Soles of feet dark.

Variations:—A recently regenerated tail is striped longitudinally. The young bear the dorsolateral white lines, which disappear early. A specimen of 60 mm. snout to vent has a remnant of stripes from vicinity of ears to sacrum. At 80 mm. the stripe is practically invisible. The coloration and markings are very constant as in *A. alboguttata.*

Measurement of type in mm.

Total length	305
Snout to vent	90
Snout to center of ear	24
Width of head at ears	12
Fore leg from axilla	34
Hind leg from groin	65
Tail	215

Remarks: The species is numerous. No specimens larger than the type were seen.

Specimens taken: 43.

Named in honor of the family of Bird of Fajardo. Their courtesy and hospitality have done much toward developing the scientific knowledge of northeastern Puerto Rico and the Cordillera keys.

HERPETOLOGICAL NOTES FROM THE PUERTO RICO AREA

Chapman Grant, Major, United States Army.

Hemidactylus

The last number of this journal contained an article, "The Hemidactyls of the Puerto Rico Region". It was remarked that *H. brookii* utters a squeak when caught. Miss Adrienne Serrano of Vieques was requested to observe whether *H. mabouia* also squeaks. Under date of April 15, 1932 she states: "The salamandras are very swift and squeak when they are caught, as a sign of protest. They try to protect themselves when pursued by hiding in cracks or the joints of the boards."

Miss Serrano's statement covers an interesting point. *H. brookii* favors stone or masonry exclusively in my experience, whereas *H. mabouia* is found inside of frame houses. I have also taken them under banana sheaths on St. John, which I here add to its range, having recently taken twenty-one specimens there, five on St. Thomas, and one on Water Island—a total of 101 *H. brookii* and 92 *H. mabouia*, all agreeing with the descriptions in the above mentioned article.

It is interesting to note that West, writing in 1793 on the reptiles of St. Croix, says *Thecadactylus rapicaudus*, a large gecko, "screams ugly when being caught".

The reason that collections do not contain more specimens of *Hemidactyls* is the old story that nocturnal species are usually poorly represented in collections, whether of birds or reptiles. I quote Alexander Wetmore in this statement.

Ameiva eleanorae sp. nov.

The subspecies *Ameiva wetmorei eleanorae,* described on page 48 of the last Journal, may be given full specific value for the following reason. An unexpected difference develops in counting the femoral pores. The original description of *A. wetmorei* gives; "13 or 14 femoral pores". This agrees with my findings of 13.3 for *wetmorei* and 12.0 for *eleanorae.* It is believed this difference is sufficient to give the form full specific rank.

Pores on 39 legs	11	12	13	14	15	Av.
A. wetmorei	0	8	15	13	3	13 3
A. eleanorae	10	19	10	0	0	12.0

Sphaerodactylus

The last number of the Journal contains an article "*Sphaerodactylus grandisquamis, A. Valid Species*". In this is mentioned the similarity between *S. macrolepis* from St. Croix and *S. danforthi* described in the July 1931 number of this Journal from Culebra and found also on Vieques. Since then I have taken of what would appear to be *S. macrolepis* 4 specimens from Water Island, 2 from Little St. James, 22 from St. John, and 6 from Congo Key. These have not yet been worked up in detail, but since not a single red-head male appears in this series of 34, it strengthens the full specific validity of *S. danforthi.*

The last issue contained a chart for determining the Sphaerodactyls of the Puerto Rico Region. The usefulness of this chart has been shown by the addition, since its issue, of 738 specimens of the various species which all fit into the chart. A total of 1783 specimens.

Mabuya semitaeniatus

This species was reestablished in an article in the July 1931 number of this Journal on the strength of 35 specimens from Mona and 27 from Culebra. The evidence has since been greatly strengthened by securing 21 additional specimens from Mona, 60 from Culebra and 6 from Buck Island, St. Thomas, all agreeing perfectly with *M. semitaeniatus.* Two more specimens of *M. sloanii*, one from Puerto Rico and one from Hicacos Island, both typical, add to the evidence. It seems that *M. sloanii* is restricted to Puerto Rico. The total series studied numbers 149 specimens of *M. semitaeniatus* and 8 of *M. sloanii.* The favorite hiding place of *M. semitaeniatus* is in dense clumps of *Opuntia Dillenii* (Ker-Gawl.) Haw., and not *O. repens* Bello as stated in the July number. I am indebted to Mr. J. M. Ortiz of Culebra and Mr. Juan Ferran of Mona for most of these specimens.

Anolis roosevelti

The magnificent giant *Anolis* described in the July 1931 number of this Journal was the only specimen I had ever seen until recently when Mr. J. M. Ortiz sent another fine specimen. Comparing these

two with my series of 52 *Anolis cuvieri* the difference is seen to be great. An outstanding difference was overlooked which should have been included in the diagnosis; i.e., loreal area decidedly sloping in *A. roosevelti* and vertical in *A. cuvieri*. The tail fin is always deeply scalloped distally between rays in *A. cuvieri* and straight in *A. roosevelti*. The fin is much higher in the latter, the animal is 10 per cent larger and the color is gray—not green or brown as in *A. cuvieri*.

Apparently the young of *A. cuvieri* has never been recorded. My collection contains numerous small examples, about 80 mm. snout to vent. The average adult is about 135. The young has the head larger in proportion—contained less than three times in snout-to-vent, whereas the adult is contained more than three times. Aside from these proportional differences, the young is a replica of the parents and in no way resembles *A. evermanni*, of which specimens nearly as large as these young *A. cuvieri* are common.

Leptodactylus pentadactylus

The Report of the Puerto Rico Agricultural Experiment Station, Mayagüez, October 1930, p. 4, states: "During the year a dozen frogs (*Leptodactylus pentadactylus*) were introduced from Dominica, where they are known as "mountain chicken". They have been released near Mayagüez in the hope that they will serve as destroyers of insects and also prove valuable as food product."

T. B. McClelland, director of the station, wrote under date of April 14, 1931: "Up to the present time, we have not retrieved any specimens of this frog, though the people who live along the Cartagena Lagoon, where these were turned loose, say that they hear them."

Dr. Stuart Danforth conducted me on December 28, 1931 to the Cartagena Lagoon. We waited at the edge of the lagoon until well after dark but heard only *Bufo marinus* and concluded that this is what the natives referred to since the introduction of this toad is a comparatively recent occurrence (1920).

It might have been better to introduce this frog in a situation more nearly resembling its native habitat. Another attempt should be made and a larger number of specimens liberated.

It seems strange that the voice of *Bufo marinus* is not more frequently heard, although the toads are legion. The first time I heard it was from a military camp at Juncos after a year's residence on the Island. Shortly after dark a distant (?) noise started, which at

first we attributed to a motorcycle, and later, when it seemed to remain stationary, we variously analyzed it as a feed chopper on one of the numerous dairies or an air drill in a quarry some two miles away. The noise started about dark and suddenly stopped shortly before daylight. A week later we camped in the same place. Captain Saulnier stepped out of the camp about daylight and then realized that the noise was nearby. A week later we heard the noise again near Cataño. A flashlight showed the author to be *Bufo marinus.*

The toad stands with the membrane under the chin vibrating but not distended; suddenly the vibration ceases; the throat and chest are moderately distended in a sweeping curve from the jaw to belly, to a size about equal to the head. The skin vibrates and a resonant sound is produced: ''ku-ku-ku''. The notes are slower than a trill and faster than one can enunciate them. These notes were made in November during very rainy weather and near semipermanent water.

Anolis poncensis, A. pulchellus and A. krugi

Stejneger shows two classes of markings, on *Anolis poncensis,* one in the extremely dry, hot and almost grassless environment, and the other amid greener surroundings. All *A. poncensis,* Stejneger, are marked with a white stripe commencing on the side of the snout, widening under the eye and across ear, more or less bordered with black to back of shoulder, where white line generally ceases. Above this stripe is one which commences above the eye and is interrupted by two dark loops bordered with white arising from lateral line on each side and running to the median line.

The first is divided into three phases—a drab one with the lateral lines and loops, a striped one, dark brown, black, and white. This form has a wide white median stripe arising between eyes and extending onto tail. A black line between this and an upper white lateral line, then a dark brown stripe, then the lateral white line arising on side of snout, then a light brown stripe, and then white of belly. The third is a spotted form wherein the neck loops are continued along the body as two rows of rings between median and lateral lines. In greener surroundings the color is perfectly described by Stejneger except for the bright greenish yellow phase which is sometimes seen.

My most interesting observation is that the outer edge of the iris is bright steel blue. It is interesting that one species of this group and one of the *cristatellus* group (*gundlachi*) should have blue eyes.

The blue is visible on a freshly killed specimen only by making the eye bulge by pressure from the opposite side. My only addition to the color description of *A. krugi* is that they are frequently seen solid sooty black above, like *cristatellus*. The dorsal black dots are specific, in *A. krugi* immediately separating this from the other two slender species. Also the heavier head is immediately recognized.

In *A. pulchellus* I add that the center of the fan is purplish in Puerto Rico, the rest crimson.

My series contains 62 specimens of *A. poncensis*, 45 of *krugi*, and 162 *pulchellus*. The range of *A. poncensis* was considerably increased when on September 6, 1931, 21 specimens were taken along the road between Aguierra and Jabos. On April 3, 1932, in company with Dr. N. L. Britton, both species were found in the same field two miles west of Coamo Springs—*A. poncensis* occupying the fence posts and *A. pulchellus* the brush. The male *A. poncensis* had the scales of the vestiginal fan, a bright straw yellow.

A ready means of separating alcoholics is: *A. krugi*, numerous black dots above and usually below prominent white lateral line; *A. pulchellus*, usually a few vertical yellow marks, outlined in dark, above and frequently some below lateral white line; *A. poncensis*, oblique marks on nape, lateral white line short. This failing, coarse dorsals.

NEW OR INTERESTING TROPICAL AMERICAN DOTHIDEALES—III. (*, **)

Carlos E. Chardon

Our knowledge of the group of parasitic fungi of the order Dothideales has been rapidly increasing in the past few years. This is specially true with regards to the tropical American forms, which have been extensively collected and studied by Sydow, Stevens, Seaver, Ciferri and Petrak. Since the writer's second contribution on that order in 1929 (**1**), the following papers have appeared dealing on that group:

Dr. H. Sydow, the outstanding authority on the order has published a paper (**12**), in collaboration with Dr. F. Petrak, on the fungi of Costa Rica, based on collections made by professor Alberto M. Brenes. A year later, Sydow published in his "Fungi Venezuelani" (**11**) the results of his expedition to Venezuela. Petrak and Ciferri, in their "Fungi dominicani" (**3**), based on collections made by the latter mycologist and by Dr. E. L. Ekman, have also increased our knowledge of this group from Santo Domingo.

Professor F. L. Stevens, of the University of Illinois, an active collector and student of the order has recently published three papers (**8, 9, 10**), based on his own collections from Costa Rica, British Guiana, Panama, Ecuador and Peru. Finally, the writer, in collaboration with Señor R. A. Toro, published the "Mycological Explorations of Colombia" (**2**) describing a number of new species from Colombia and Panama.

The number of new species described in these six contributions, plus those described in the present paper, give a sum total of fifty-four, which is relatively large, considering that the Dothideales was up to recent times believed to be a small and unimportant order of fungi. The total number of *Phyllachora* from tropical America reported by Theissen und Sydow in their classical work on the group (**13**) in 1915 was 322. Since that time, considerable attention has been given to their collecting and study, and the number of known species has been greatly increased.

There seems to be still a wide field for investigation and oppor-

(*) Contribution from the Biology Department, University of Porto Rico, No. 2.

(**) For first paper see Mycologia 19: 295–301. 1927. For second, see Jour. Dept. of Agric., Porto Rico, 13: 3–15. 1929.

tunities in this group for the collector and taxonomist. Cuba, the entire territory of Mexico, Guatemala, Haiti, Jamaica, the Lesser Antilles, the greater portion of the Andean region, the immense Amazon basin, Bolivia and Peru, may still be considered as *terra incognita*, as far as our knowledge of this order is concerned, with only a few scattered collections being reported here and there. The only tropical countries in America whose species are well known are Porto Rico and Costa Rica, and even in these two small countries, as evidenced by the present paper, new species are still to be found. Santo Domingo, certain portions of Colombia, Panama and the coast of Venezuela have also been fairly well studied, but still need considerable exploration.

It is hoped that this contribution may help to keep alive the interest in this important order of plant parasites and stimulate further taxonomical research and exploration. A great deal has yet to be accomplished before we have a comprehensive knowledge of the species of the group.

The writer wishes to express his appreciation to various mycologists and correspondents who have facilitated the progress of this investigation by communicating specimens and portions of type material from the various world herbaria. Among these are: Dr. H. Sydow, of Berlin, who has supplied a number of his types from Costa Rica and Venezuela; Dr. Augusto Scala, director of the Museo de la Plata, Argentine, who has generously mailed for examination the complete set of types of Phyllachora described by the late Dr. Carlos Spegazzini; Dr. John A. Stevenson, in charge of the mycological collections at the Bureau of Plant Industry, Washington, D. C., for sending specimens collected by the late Dr. W. A. Kellermann, by Dr. Paul C. Standley and Mr. H. Schmidt, in Central America; Dr. F. L. Stevens, of the University of Illinois, for supplying portions of type material of his collections from various tropical countries; Dr. Fred J. Seaver, curator of the New York Botanical Garden, for remitting his collections from Trinidad and other undetermined material from the Garden herbarium, and Dr. R. Ciferri, of Moca, Santo Domingo, for sending an interesting collection made by him and by Dr. E. L. Ekman in that neighboring island. Professor H. H. Whetzel has been keenly interested in the progress of our work and made available all the material needed from the herbarium at Cornell University. His cooperation in this work has been a great stimulus and source of inspiration which deserve due acknowledgment. To the various other mycologists who have contributed more limited amounts of material and to the phanerogamists who

have identified the hosts, especially to Dr. N. L. Britton, the writer wishes to express his appreciation.

My laboratory assistants, Miss Josefa Velázquez and Miss Luz M. Vilariño, deserve credit for their help in sectioning the material, making some observations and records of specimens. Thanks are due also to the Rev. Padre Rivera, of Humacao, and to Mr. Rafael A. Toro for the preparation of the latin diagnoses.

The system of classification of the order into families, tribes and genera, given by Theissen und Sydow in "Die Dothideales" (**13**) is followed here, as the best treatment available. The tribal differences in the Phyllachoraceae, especially between the Trabutiineae and Scirrhiineae, based on the subcuticular and subepidermal position of the stromata, though not entirely satisfactory and difficult to follow in practice, is still accepted here.

Family Phyllachoraceae

Tribe 1. Trabutiineae.

Trabutia Basanacanthae Chardon sp. nov.

Stromata hypophylla subcuticularia, papillata nigra; loculi epidermales; asci paraphysati, clavati cylindracei; sporae distichae v. inordinatae, hyalinae ellipticae.

Stromata hypophyllous, small, about 1 mm. or less in diam., raised above the leaf surface, black, shiny, becoming confluent and forming much larger, concentrically arranged conspicuous stromata, 3–7 mm. in diam. with the surface papillate with numerous protruding necks; the position of the stroma being distinctly subcuticular; locules at first few 1–3, seated on the epidermal layer, with the roof-like clypeus above, flat conical in shape, 200–240 × 125–140 u, later becoming very numerous in the larger, confluent stromata; asci clavate to cylindrical-clavate, 8-spored, 45–54 × 12–14 u, with the spores partially biseriate to inordinate; spores hyaline, 1-celled, long elliptical, 9–12 × 5–6 u; paraphyses present. (Plate XIV, fig. 4)

This is a distinct species, apparently undescribed heretofore and characterized by the large, concentrically arranged stromata resembling those of *Catacaumella Gouaniae* Stevens. The position of the stroma is distinctly subcuticular, being located between the cuticle and the large, conspicuous row of epidermal cells.

On *Basanacantha* sp.

Brasil: Parecy, Bureau Plant Ind. *66619* (coll. J. Rick) 1924 (*type*, communicated by J. A. Stevenson).

Trabutia brasiliensis (Speg.) comb. nov.

Phyllachora brasiliensis Speg., Fungi Arg. **4**: 142.

The type specimen deposited at the Museo de la Plata has been

examined. It consists of only two small leaves and the asci and spores were readily examined and measured; the asci are clavate to subclavate, 67–78 × 22–29 u, with the spores broad ellipsoidal arranged biseriately or inordinate, 14–20 × 9–12 u. Cross sections of the leaves showed the position of the stroma distinctly subcuticular and the species should be removed to *Trabutia*. (Plate XIV, fig. 1)

On Rutaceae, probably *Xanthoxylon*.

BRASIL: Apiahy, Puiggari *1486*, April 1881 (*type*).

TRIBE 2. SCIRRHIINEAE.

Catacauma Serjaniae (Speg.) comb. nov.

Phyllachora Serjaniae Speg. Anal. Mus. Nac. Buenos Aires **23**: 92. 1912.

Characterized by the large, conspicuous, concentric stromata in the epiphyll. The position of the stroma is subepidermal and hence the fungus is a *Catacauma* under Theissen und Sydow's treatment.

On *Serjania caracasana*.

ARGENTINE: Calilegua, Salta, (Museo La Plata Speg. herb *188*) Nov. 1911 (*type*).

Catacauma Amyridis (Seaver) comb. nov.

Phyllachora Amyridis Seaver, Mycologia **20**: 215. 1928.

A microscopical examination of the type material, from Desecheo Island, shows that the stroma is subepidermal and the species falls under *Catacauma* in Teissen & Sydow's keys. It is a beautiful and conspicuous species.

On *Amyris elemifera* L.

PUERTO RICO: Desecheo Island, Britton, Cowell & Hess. *1633*, Feb. 18–19, 1914 (*type*, communicated by F. J. Seaver).

SANTO DOMINGO: Boca del Infierno, Prov. Samaná, Ciferri *4560* (coll. Eckman), June 24, 1930.

According to Seaver (loc. cit.) the species is also known to occur in Cuba, Bahamas, Florida.

Catacauma venezuelensis (Sydow) comb. nov.

Phyllachora venezuelensis Sydow, Ann. Mycol. **28**: 107. 1930.

An examination of the type (no. *830*) shows the epidermal position of the stroma, which makes the fungus fall under *Catacauma*. This is a very conspicuous and beautiful species: The stromata are epiphyllous, black, circular, 2–5 mm. across, with the surface distinctly papillate from the protruding locular necks; spores biseriate or inordinate, rarely uniseriate, ovate to elliptical, 10–18 × 9–14 u. In

the Costa Rican material, the fungus occurs on the pods also. (Plate XV, fig. 1)

On *Machaerium robiniaefolium* (D. C.) Vogel.

VENEZUELA: Puerto La Cruz, Sydow f. exot. exs. *830,* Jan. 6, 1928 (*type*).

On *Mach. Humboldtianum* Vogel.

VENEZUELA: La Victoria, Aragua, Sydow f. exot. exs. *831,* Jan. 27, 1928.

On *Mach. Moritzianum* Benth.

VENEZUELA: Cotiza, near Caracas, Sydow *60,* Dec. 19, 1927.

On *Mach. biovulatum* Micheli.

COSTA RICA: Near San José, Schmidt *CR 47, 52, 54* & *61* (Bureau Plant Ind.) 1928–29 (communicated by J. A. Stevenson).

On *Machaerium* sp.

TRINIDAD: North out to Belle View, Seaver *3142,* Mar. 12, 1921; Gasparee Island, Seaver *3437,* April 27, 1921.

Catacauma Puiggarii (Speg.) comb. nov.

Phyllachora Puiggarii Speg., F. Puigg. no. 319.

A beautiful species with small, shiny stromata. A microscopic examination of the type specimen shows that the stroma is distinctly supepidermal, and hence the fungus is a *Catacauma.* (Plate XIV, fig. 7)

On Leguminosae ("folia parvula imparipinnata").

BRASIL: Apiahy, Sao Paulo, Puiggari *2770* (Museo La Plata Speg. herb. *231*) 1888 (*type*).

Catacauma rimulosa (Speg.) comb. nov.

Phyllachora rimulosa Speg., Bol. Acad. Nac. Ci. Cordoba **23**: 568. 1919.

A distinct conspicuous species apparently common in the vicinity of San José, Costa Rica. The clypeus is sub-epidermal and hence would fall under *Catacauma* in Theissen and Sydow. The stromata are epiphyllous, large, irregular but definite, conspicuous, black shiny, 3–6 mm. across, papillate in the surface due to the minute protruding ostiola; spores uniseriate, elliptical, 14×8 u, sometimes bigutulate. In the same stromata are found locules producing linear, fusiform conidia, $5–8 \times 1$ u, hyaline, 1-celled, born on large filiform sterigmata, $20–25 \times 1$ u.

In the original Spegazzini specimen, the host is reported as a Myrtaceae. In the publication of the original diagnosis, it is given as "*Eugenia* (costaricensis?)". In the several specimens collected

by R. Schmidt, the host has been determined as *Myrcia Oerstediana* Berg.

On *Myrcia Oerstediana Berg.* (det. P. C. Standley).

COSTA RICA: Near San José, coll. A. Tonduz (Museo La Plata Speg. herb. *177* Dec. 1897, (*type*); near San José, Schmidt *CR 6, 13, 20, 88 & 91* (Bureau Plant Ind.) 1928–29 (communicated by J. A. Stevenson).

Catacauma tropicalis (Speg.) comb. nov.

Phyllachora tropicalis Speg.—F. Argent. III, n. 67.

The stromata in the type specimen, which have been carefully sectioned, show that the clypeus is subepidermal and hence the species belong to *Catacauma.* This character was unknown to Theissen und Sydow (**13**) who never saw the type "original nicht geschen", so they included it as a *Phyllachora.*

On *Psidium Thea.*

ARGENTINE: Cordoba (Museo La Plata Speg. herb. *204*) no date ? (*type*).

PHAEDOTHIOPSIS EUPATORII Stevens, Bot. Gaz. **69**: 252. 1920.

Stevens says with regards to the morphology of this species: "The clypeus is strictly epidermal, and under it very numerous loculi develop, each with an ostiole reaching through the clypeus. The occasional pressing of the perithecia into the mesophyll sometimes gives this the appearance of closer relationship to the Phyllachoriineae, but its relationship is clearly with the Scirrhiineae". This is the first record of the species outside of Porto Rico.

On *Eupatorium portoricense* Urb.

PUERTO RICO: Dos Bocas, below Utuado, Stevens *6866*, Dec. 30, 1913 (*type*).

On *Eupatorium* sp.

HONDURAS: Vicinity of Siguatepeque, Bureau Plant Ind. *56448* (coll. P. C. Standley) Feb. 14–27, 1928 (communicated by J. A. Stevenson).

TRIBE 3. PHYLLACHORIINEAE.

Phyllachora vaginata Chardon sp. nov.

Stromata elliptica v. linearia, sparsa, atra; loculi numerosi globosi; asci paraphysati, cylindracei; sporae octonae, hyalinae, oblique monostichae v. distichae, ellipticae.

Stromata long-elliptical to linear, 1–1.5 mm. × .5 mm., scattered, seldom coalescing; black, conspicuous in the epiphyll, appearing in the hypophyll at first as discolored, slightly raised leaf tissue, with the black stroma appearing later, not surrounded by a conspicuous

zone of dead tissue; locules several (2–4) in each stromata, approximately globose, flask shaped or angular on adjacent sides; asci cylindrical 8-spored, 65–80 × 9–12, with the spores obliquel‥ uninseriate or partially biseriate; spores 1-celled, hyaline, elliptical, 9–12 × 5–6 u; paraphyses present.

The spores of this species agree in shape and measurements with those of *Phyllachora guianensis* Stevens, but it is different in stromatal characters, lacking the characteristic zone of dead host tissue and in other minor characters. Hence the species is apparently new and described as such. The three host grasses are very closely related species.

On *Paspalum vaginatum* Sw.

SANTO DOMINGO: El Jovero, Seibo, Ciferri *4577* (coll. Ekman), July 24, 1930 (*type*).

On *Paspalum distichum* L.

SANTO DOMINGO: Same locality, Ciferri *4604*, (coll. Ekman) July 24, 1930.

On *Paspalum Saugetti* Chase.

SANTO DOMINGO: Cuesta de Piedras, Cordillera septentrional, Prov. Puerto Plata, Ciferri *4803*, Dec. 9, 1930.

PHYLLACHORA CORNISPORA-NECROTICA Chardon. Bol. Real Soc. Esp. Hist. Nat. **28**: 116. 1928.

Phyllachora Paspali Earle in herb.

Most specimens are characterized by the possession of a dead zone of host tissue around the stromata (see plate 1, fig. 1, loc. cit.) but this character is not found in all the specimens. The shape of the spores, however, is distinctive; they have an attenuated appendage in the lower end, similar to the spores of *Phyllachora cornispora* Atkinson.

The species is known to occur in Colombia, Panama and Porto Rico. This is the first report from Guatemala.

On *Paspalum virgatum* L.

GUATEMALA: Los Amates, Dept. Izabal, Bureau Plant Ind. *60868* (coll. W. A. Kellermann), Feb. 15, 1908 (communicated by J. A. Stevenson).

PHYLLACHORA MOLINAE Chardon, Jour. Dept. Agric. Porto Rico **14**: 252. 1930.

This was found to be a common species in the Andean region of Colombia, producing long yellowish spots, and linear rows of stromata 2–5 mm. long (like *Ph. Chaetochloae* Stevens). The fact that

it is also found in Santo Domingo indicates a possible wider geographical distribution.

On *Paspalum paniculatum* L.

SANTO DOMINGO: Estación Agronómica, Haina, Ciferri *4574*, Dec. 12, 1925.

Phyllachora Standleyi Chardon sp. nov.

Stromata amphigena, ad epiphyllum prominulo pustulata in circulum disposita, loculi 1–3 in quoque stromate, saepe circulares; asci paraphysati, cylindracei v. leniter clavulati, sporae monostichae, ovoideae, hyaline, continuae.

Stromata amphigenous, conspicuous, black, not shiny, more visible and pustular in the upper surface of the leaf, roughly circular, not exceeding 1 mm. in diameter, 1–3 loculate, with the locules facing the upper surface and the stroma much more conspicuous above than below, sometimes the black stroma scarcely reaching the hypophyll; locules roughly circular, or angular resulting from lateral pressure, 160–300 × 150–200 u; asci cylindrical-clavate, 8-spored, 80–95 × 10–11 u, with the spores uniseriate; spores 1-celled, hyaline, ovoid, 10–12 × 5–6 u; paraphyses present.

This species has spores resembling those of *Phyllachora Leptochloae* Chardon, but they are ovoid instead of elliptical. The stromatic characters are also peculiar to the species: the hypophyll is very often devoid of the stromatic tissue, but it is found abundantly in the epiphyll. The species is dedicated to its collector Dr. Paul C. Standley, the well known tropical explorer and phanerogamist.

On *Panicum sphaerocarpon* Ell.

HONDURAS: Vicinity of Siguatepeque, Bureau Plant Ind. *56023* (coll. P. C. Standley) Feb. 14, 1923 (*type*, communicated by J. A. Stevenson).

PHYLLACHORA ANTHEPHORAE Sydow, Ann. Mycol. **13**: 439. 1915.

The type of this species is from Jamaica (Mayor *350*) and it has been made available by the courtesy of its collector. It is also known to occur in Costa Rica on the authority of Stevens (7). It had not been recorded from Porto Rico, but the following two collections, examined at the New York Botanical Garden agree with the type. It is to be noted that the species has not been found by recent collectors in the island.

On *Anthephora hermaphrodita* (L.) C. Kuntze.

PORTO RICO: "Manati ad Coto *6735* Sintenis Collector" (at N. Y. Bot. Garden); "Santurce Mr. & Mrs. A. A. Heller collectors" (idem).

Phyllachora minima Chardon sp. nov.

Stromata amphigena, punctiformis, sparsa v. saepius laxe gregaria, minuta, nigra 1–2 loculates; loculi ad mesophyllum; asci cylindracei, octonae; sporae monostichae, continuae, hyalinae; paraphysis filiformibus paucis.

Stromata very small, punctiform, scattered or seldom coalescing, black, amphigenous, less than .5 mm. across, 1-loculate or seldom 2-loculate thru coalescence; locule in the mesophyll, stroma brownish black, true Phyllachora-like, surrounded on all sides by stroma, subglobose but slightly angular in the corners, 80–110 × 75–100 u; asci cylindrical, 8-spored, 60–72 × 7–8 u, with the spores uniseriate; spores hyaline, 1-celled, broad elliptical with obtuse end, smooth, 7–9 × 4–5 u, paraphyses filiform, scarce.

The stromata in this species are very small, resembling those of *Phyllachora microspora* Chardon and *Ph. Panici* (Rehm.) Theiss & Sydow. In the former species, the spores are long-elliptical, 5–6 × 4–4.5 u, similar in shape to our specimen, tho a trifle smaller. *Ph. Panici* occurs on *Panicum* and is known only from the type locality from Rio Janeiro. *Ph. Boutelouae* Rehm. and *Ph. boutelouicola* Speg. occurring on *Bouteloua* in Argentine, have larger spores. Apparently the species is new to science.

Bouteloua heterostega (Trin.) Griff.

PUERTO RICO: Near Reform School, Mayagüez, Chardon *3204*, Dec. 6, 1931 (*type*).

PHYLLACHORA CLORIDICOLA Speg., Anal. Mus. Nac. Buenos Aires III, **12**: 416. 1909.

The type species is reported on *Chloris radiata* from La Rioja, Argentine. It has not been made available to the writer, but the other known Argentine specimen has been examined and agrees well with the published diagnosis. The Venezuelan material has asci and spores of the same shape and measurements, but the position of the stroma is different, since it is always amphigenous, and not restricted to the epiphyll. The occurrence of this species in Venezuela, suggests a wider geographical range.

On *Chloris radiata* (L.) Sw.

ARGENTINE: La Rioja (coll. Speg. ?) Dec. 1904 (*type* not seen).

VENEZUELA: near Ocumare, Toro *59*, Dec. 1930.

On *Chloris* sp.

ARGENTINE: Juarez Celman, Cordoba (Museo La Plata Speg. herb. *252*) Jan. 5, 1930.

Phyllachora Leersiae Chardon sp. nov.

Stromata amphigena, nigra minute punctiformis, sparsa, linearibus disposita, loculi solitari, utrimque planissima lenticulares ad mesophyllum immersi; asci paraphysati, cylindracei-clavati, octoni; sporae inordinatae v. monostichae, hyalinae, continuae, elliptico-subfusoideae, utrimque subacutiusculae.

Stromata amphigenous, black, small, punctiform, about .5 mm. across, scattered or in groups with a linear arrangement, inconspicuous; locule single, 200–250 × 120–135 u, flat lenticular or oblong, located in the mesophyll, with black stroma on all sides; asci cylindrical-clavate, 8-spored, 54–60 × 12–14 u, with the spores biseriate or inordinate; spores hyaline, 1-celled, long elliptical to navicular, with ends subacute, 16–19 × 6–7 u; paraphyses present.

This is apparently a new species on a genus of Gramineae not previously known to have been parasitized by a *Phyllachora*. The navicular spores, inordinately arranged in the subclavate asci are characteristic.

On *Leersia* sp., aff. *monandra* Sw.

SANTO DOMINGO: Road to San José de las Matas, Prov. Santiago, Ciferri *4557*, July 12, 1931 (*type*).

Phyllachora Leptochloae Chardon sp. nov.

Stromata amphigena, nigra pallescens, 2–3 loculatae ad mesophyllum immersae; loculi globosi; asci paraphysati, cylindracei-clavati; sporae saepius oblique monostichae, ellipticae, continuae, hyalinae; stylosporis granularibus, viridis.

Stromata amphigenous, conspicuous, black, not shiny, equally visible on both sides of the leaf, roughly circular but tending to be elongate and parallel to the long axis of the leaf, 2–3 loculate with the stroma in the mesophyll; locules nearly glogose, 200–250 × 150–200 u; asci cylindrical clavate, 8-spored, 85–100 × 10 u, with the spores obliquely uniseriate; spores 1-celled, hyaline, smooth, navicular, 12–15 × 5–7 u, stylospores present, 12–16 × 3 u, granular and with light greenish contents, paraphyses present.

The stromata are characteristic of the graminicolous *Phyllachorae*, black, conspicuous, not shiny, visible on both sides of the leaf; the locules (2 to 3) are approximately globose or completely immersed in the mesophyll and surrounded on all sides by the black stromatic tissue. No species is reported by Theissen und Sydow (**13**) nor in subsequent works on tropical America, on *Leptochloa*.

On *Leptochloa virgata* (L.) Beauv.

HONDURAS: La Fragua, Bureau Plant Ind. *55759* (coll. P. C. Standley) Feb. 7, 1928 (*type*, communicated by J. A. Stevenson).

PHYLLACHORA CHAETOCHLOAE Stevens, Ill. Biol. Monog. **83**: 19. 1923

Ciferri's specimen from Santo Domingo agrees very well with the type from Trinidad (Stevens *882*) in ascospore shape and dimensions, as well as in the possession of two distinct types of conidia. Seaver's collection from Trinidad appears to be the same.

On *Chaetochloa setosa* (Sw.) Scrib.

SANTO DOMINGO: Santiago, flats near Yaque river, Ciferri & Ekman *no number,* Dec. 1930.

On *Chaetochloa* sp.

TRINIDAD: Heights of Aripo, Seaver *3237*, Mar. 16, 1921.

PHYLLACHORA ANTIOQUENSIS Chardon, Bol. Real Soc. Esp. Hist. Nat. **28**: 118. 1928.

This is one of the most characteristic graminicolous *Phyllachorae* with its conspicuous black stromata covering a large part of the host tissue. The host is a tall grass, seldom showing inflorescence and quite common in waste places in the "tierra templada" of Colombia. These are the first reports outside of Colombia.

On *Imperata contracta* (H. B. K.) Hitch.

SANTO DOMINGO: Sabana de la Mar, Cordillera Central, Prov. Samaná, Ciferri *4555* (coll. Ekman, July 13, 1930).

On *Imperata brasiliensis.*

SANTO DOMINGO: Pimentel savanna, San Fco. de Macoris, Ciferri *4550*, Feb. 1930.

On *Imperata* sp.

TRINIDAD: Piarco Savanna, Seaver *3205,* Mar. 13, 1921.

Phyllachora Sorghastri Chardon sp. nov.

Maculae indeterminatae; stromata amphigena, nigra, linearia; loculi 1–2 lenticulares v. elliptici; asci paraphysati, cylindracei clavati; sporae inordinatae, continuae, hyalinae, ellipticae, obtusiusculae, guttulatae.

Stromata amphigenous, black, linear, 1–3 mm. long × .5–1.0 mm. across, producing slight discolored spots indefinite in outline, locules 1–2, lenticular or elliptical, 160–225 × 100–140 μ, surrounded on all sides by black stromata; asci cylindrical-clavate, 8-spored, 90–110 × 16–18 μ, with the spores inordinate; spores hyaline, 1-celled, long elliptical, with one end obtuse, 14–16 × 6–8 μ, provided with many small oil droplets; paraphyses present.

An apparently new species, on a host not previously known to have been parasitized by a *Phyllachora.* The subclavate asci and inordinate spores are typical.

On *Sorghastrum parviflorum* H. & Ch.

SANTO DOMINGO: Sabana de la Mar, Samaná, Ciferri *4579* (coll. Ekman), July 9, 1930 (*type*).

Phyllachora tetraspora Chardon sp. nov.

Stromata conspicua ad epiphyllum, nigra pallescens, linearia, opaca ad hypophyllum, fusca maculla cincta; loculi 1–2 globosi, extus grosse clypei, intus contextu atro-fuscae; asci paraphysati, clavati, tetraspori, guttulati; sporae inordinatae, hyalinae, continuae, ellipticae, 1-guttulatae.

Stromata conspicuous in the epiphyll, black, not shiny, linear, 2.5 mm. long × .5–1.0 mm. broad, faintly visible in the hypophyll, in the form of brown, ashy spots, wrinckled in its surface; locules 1–2, globose flattened to angular, 150–250 × 120–165 u, with thick clypei on the top, and black-brownish stromatic tissue on the sides and bottom; asci clavate, 54–65 × 12–14 u, 4 spored, provided with numerous, globose, oil droplets, with the spores inordinate; spores hyaline, 1-celled, long-elliptical, 16-19 × 5–7 provided with a small oil droplet; paraphyses present. (Plate XIV, fig. 2)

A species forming conspicuous, black, linear stromata. It is different from other species occurring on the tribe Bambusae, in possessing 4-spored asci. Only known from the type collection.

On *Bambos vulgaris* Schrad.

SANTO DOMINGO: Hato del Yaque, Prov. Santiago, Ciferri *4554*, July 10, 1931 (*type*).

Phyllachora Guaduae Chardon sp. nov.

Stromata amphigena, atra, nitidula, linearia disposita; loculi 1–2 lenticulares, ad mesophyllum immersi; asci paraphysati, cylindracei-clavati, octoni; sporae distichae, continuae, hyalinae, fusoideae utrimque acutae.

Stromata amphigenous, very conspicuous, equally visible on both surfaces of the leaf, black, shiny, 3–4 mm. long × 1 mm. wide, arranged loosely in long linear rows, parallel to the main axis of the leaf, causing yellow longitudinal streaks in the leaves; locules 1–2 in cross section, lenticular or angular on the adjacent sides, 160–200 × 120–150 u, completely immersed in the mesophyll of the leaf, surrounded on all sides by the thick stroma; asci cylindrical, clavate, 8-spored, with the spores biseriate in the main body of the ascus, 70–95 × 12–15 u; spores 1-celled, hyaline, smooth, long fusoid with pointed ends, 16–18 × 6–7 u; paraphyses filiform, inconspicuous.

Differs from *Phyllachora gracilis* Speg., reported on a Bambusaceae from Peribebuy, Brasil, in having slightly smaller spores, and very conspicuous linear stromata over twice as long. The species was erroneously determined by Chardon (**2**) as *Phyllachora bonariensis* Speg., based on Gaillard's no. *257* from Venezuela, which is deposited at the N. Y. Botanical Garden and appeared determined as such but both are species. It seems to be a common fungus on the well known "guadua".

On *Guadua latifolia* Kunth.

COLOMBIA: Quebrada Sinifana, Antioquia, Chardon *93*, May 25, 1926; Hacienda El Hatico, between Cerrito and Palmira, Chardon & Nolla *346*, May 23, 1929 (*type*); along Quindio river, near Armenia, Chardon *710*, July 14, 1929.

VENEZUELA: Atures "Haut Orenoque", Gaillard *257*, Aug. 1887 (at N. Y. Bot. Garden).

Phyllachora Kyllingae Chardon sp. nov.

Stromata amphigena, in limbo utrimque perspicua, atra, nitidula, ad epiphyllum innata superficialia, ad hypophyllum atra pallescens; loculi bilineares, 5–8; asci paraphysati, cylindracei-clavati, octoni; sporae continuae, hyalinae, fusoideae, acutae, distichae.

Stromata amphigenous, 1–2 mm. long × .5 mm. wide, equally visible from both leaf surfaces, black, shiny and pustular in the epiphyll, dull black and smooth in the hypophyll; fructification compound, made up of 5 to 8 locules all immersed in intense black stroma and arranged in two rows, the upper one with 3–5 angular locules, 150–175 × 65–80 u (a few 250 × 150 u) and a lower row of 2–3 locules smaller in size; asci cylindrical-clavate, 70–85 × 6–7 u, 8-spored; spores 1-celled, hyaline, long navicular, 15–17 × 4–5 u, biseriate in the ascus; paraphyses present. (Plate XIV, fig. 6)

The stromata are characteristic of the graminicolous *Phyllachoras*, slightly raised and shining black in the epiphyll; the stroma is characterized microscopically by possessing two rows of locules. There being apparently no species reported on *Kyllinga*, and the stromatic and spore characters being so distinct and peculiar, it is hereby described as a new species.

On *Kyllinga brevifolia* Rottb.

COSTA RICA: Near San José, H. Schmidt *CR 28* (Bureau Plant Ind.) 1928–29 (*type*, communicated by J. A. Stevenson).

PHYLLACHORA GALACTIAE Earle; Seaver *in* Britton, Bahama Flora: 633. 1920.

Phyllachora Lathyri (Lev.) Theiss. & Sydow *in* Seaver and Chardon, Sci. Surv. Porto Rico 8^1: 52. 1926.

Phyllachora gelatinosa Sydow, Ann. Mycol. **28**: 104. 1930.

Phyllachora Bradburyae Stevens (?) in herb.

The type species is from New Providence, Bahamas on *Galactia rudolphoides*. Stevens and Dalbey (**6**) referred numerous forms collected in Porto Rico on *Galactia striata* and *Bradburya virginiana*, to *Phyllachora Lathyri* (Lev.) Theiss. & Sydow. Chardon (Mycol. **12**: 319) referred two collections of Whetzel and Olive on *Galactia* to *Ph. Galactiae* Earle, after confirmation by the late F. S. Earle. On the basis of this divergence of opinion, Seaver and Chardon (**5**)

referred the species on *Bradburya* to *Ph. Lathyri,* following Stevens, and the species on *Galactia* to *Ph. Galactiae,* following Chardon and Earle.

This reference to two different species appears to be a mistake, since *Ph. Lathyri* is a temperate species occurring on *Lathyrus* in Europe, Asiatic Russia and Central Asia, while the Porto Rican species is strictly tropical. A microscopic reexamination of all the Porto Rican material, both on *Galactia* and *Bradburya* has convinced the writer that they belong to one species, namely *Ph. Galactiae* Earle. The same species was reported by Toro (**14**) from Santo Domingo on *G. striata* and by Chardon and Toro (**2**) from various stations from Colombia on the same host.

Sydow (**11**) has recently described *Ph. gelatinosa* sp. nov. on *Bradburya pubescens* from Venezuela, and the material is very suggestive of *Ph. Galactive* and it is here reduced to synonymy. A specimen recently collected by Toro in Venezuela on *Bradburya* is certainly *Ph. Galactiae,* with spores navicular, biseriate, 18–20 × 5–6 u. A specimen at the N. Y. Botanical Garden, collected by Stevens from Ecuador on *Bradburya* is also identical.

This settles in our judgment the confusion which existed, and *Ph. Lathyrii* is excluded from the flora of tropical America, while *Ph. Galactiae* is now understood in a clearer light and its range greatly extended.

On *Galactia striata* (Jacq.) Urban.

PUERTO RICO: Johnston, *4945;* Stevens, *5644;* Fink, *1661* & *2091;* Whetzel & Olive, *574* & *575;* Chardon, *920, 1528* & *1529;* Whetzel, Kern & Toro, *2582.*

SANTO DOMINGO: Kern & Toro, *213* & *277.*

COLOMBIA: Chardon, *416, 431, 575* & *683.*

On *Galactia dubia* DC.

PUERTO RICO: Woods near sea, Earle *27*, Summer 1903.

On *Bradburya virginiana* (L.) Kuntze.

PUERTO RICO: Stevens, *1887, 4314, 5036* & *5991;* Whetzel & Olive. *651.*

ECUADOR: near Teresita, col. F. L. Stevens no *188,* Oct. 31, 1924 (det. as *Ph. gelatinosa* sp. nov.)

VENEZUELA: near Ocumare, coll. R. A. Toro no. *117,* Dec. 25, 1930.

On *Bradburya Plumieri.*

ECUADOR: near Teresita, Stevens *108,* Oct. 29, 1924 (specimen at N. Y. Botanical Garden labelled *Phyllachora Bradburyae* sp. nov.)

On *Bradburya pubescens.*

VENEZUELA: Puerto La Cruz, Sydow f. exot. exs. *825*, Jan. 1, 1928 (type of *Ph. gelatinosa* sp. nov.)

Phyllachora Chamaefistulae Chardon sp. nov.

Stromata epiphylla, atra, nitidula, errumpentia, sparsa, globosa, matrici immersa 1–2 loculata; loculo globosi ad epiphyllum dehiscenti; asci cylindracei-clavati; sporae distichae, hyalinae, fusoideae, grosse guttulate.

Stromata epiphyllous, black, shiny, slightly raised, scattered, round, about 0.5 to 0.8 or seldom 1 mm. in diameter, rarely hypophyllous, with the stroma clearly occupying the mesophyll of the leaf, with 1–2 locules; locules approximately circular or sometimes slightly irregular, opening in the epiphyll, 190–240 × 140–170 u; asci 8-spored, cylindrical-clavate, 95–110 × 12–14 u with the spores biseriate in the ascus; spores hyaline, 1-celled, long navicular, large, 26–30 × 5–6 with a conspicuous, large oil drop in each spore; paraphyses present.

This is apparently an undescribed species and the first one known on the genus *Chamaesfistula*, although others are known to occur on its closely related genus *Cassia*. The large, navicular, uniguttulate spores are characteristic.

On *Chamaefistula antillana* Britton & Rose.

PUERTO RICO: Mountains above Yauco, Whetzel, Chardon & Toro, *3239*, May 24, 1931 (*type*).

Phyllachora Noblei Chardon sp. nov.

Maculae fuscae, amphigenae, determinatae; stromata globosa pallescens atra; loculi globosi; asci paraphysati, cylindracei clavati; sporae distichae v. inordinatae, hyalinae, fusoideae.

Spots slightly exceeding the stromata in the form of a brownish dead zone, encircling them and about .5 mm. across; stromata approximately circular, black, amphigenous, not shiny, flat, about 5 in diameter, 1–2 loculate; locules globose or slightly flattened on adjacent wide 180–215 × 160–100 u; asci cylindrical-clavate; 8-spored, 65–84 × 10–12 u, with the spores biseriate or inordinate; spores hyaline, 1-celled, navicular, or long lemon-shaped, smooth, 14–16 × 8–10 u; paraphyses present. (Plate XIV, fig. 3)

A rare species known from two collections from the limestone hills along the road to Cataño. It is probably extensive with the tertiary limestones of the north coast of Porto Rico, where the host is abundant. Dedicated to Mr. David Noble, enthusiastic geological explorer who accompanied the writer in the expedition in which the type specimen was found.

On *Chiococca alba* (L.) Hitch.

PUERTO RICO: Limestone Hills along Cataño road in Iriarte Farm, Whetzel, Kern & Toro *2796*, June 28, 1924; Hills along the Bayamón–Toad road, Chardon *3512*, Jan. 13, 1932 (*type*).

Phyllachora perplexans Chardon nom. nov.

Catacauma Ocoteae Stevens Bot. Gaz. **69**: 251. 1920.

The nomenclature of this species is somewhat perplexing. Stevens described it as a *Catacauma* but evidently he did not make median sections thru the stromata. Careful sectioning has been shown that there are clypei above and below, typically *Phyllachora*-like. The species is thus removed to Phyllachora but the specific name *Ocoteae* is untenable in that genus, since there is *Ph. Ocoteae* P. Henn. from Brasil. Hence a new specific name, *perplexans*, is proposed here.

On *Ocotea leucoxylon* (Sw.) Mez.

PUERTO RICO: Monte Alegrillo, near Maricao, Stevens *732*, Mar. 4, 1913 (*type*).

PHYLLACHORA OCOTEICOLA Stevens & Dalbey Bot. Gaz. **68**: 57. 1919.

Ph. Ocoteicola Speg. in herb.

Ph. Ocoteicola var. *costaricensis* Stevens, Illinois Biol. Monog. **11**: 37. 1927.

Examining Spegazzini's types, furnished by the Museo de la Plata, a specimen was found on *Ocotea diospyrifolia* from Calilegua, Argentine, which is labelled "*Phyllachora ocoteicola* Speg. n. sp." This name was not published, and the same specimen was referred by Spegazzini to *Ph. Ocoteae* P. Henn. (See Myc. Argent. no. *1450*). The Porto Rican material and the type of *Ph. ocoteicola* Stevens & Dalbey have been examined: the original description has spores "17 × 54 u", which is a gross typographical mistake, and it has been corrected to the actual measurements found, 16–20 × 5–7 u. Stevens new variety *costaricensis*, has been examined: it was based on minor stromatal characters, which were also found in other specimens and the validity of the variety is questioned.

On *Ocotea leucoxylon* (Sw.) Mez.

PUERTO RICO: Monte Alegrillo, Stevens *4768*, Nov. 14, 1913 (*type*); Monte de Oro, Stevens *5969*, Dec. 3, 1913; Finca María, Yauco, Whetzel, Kern & Toro, *2510*, June 18, 1924.

On *Ocotea* sp.

COSTA RICA: Peralta, Stevens *390*, July 12, 1923.

Phyllachora catsbyana Chardon sp. nov.

Stromata amphigena, parva, atra, nitidula, ad epiphyllum errumpentia, loculi singuli, subglobosi; asci paraphysati, cylindracei, octoni; sporae monostichae, hyalinae, continuae, ellipticae.

Stromata amphigenous, small, angular, about 1 mm. across, black shining and raised in the epiphyll, dull black and smooth below; locule single, subglobose, 200–240 × 175–210, with heavy clypeus above, and dull black stromatal tissue on the sides and below; asci cylindrical, 8-spored, 75–85 × 10–11 u, with the spores uniseriate; spores hyaline, 1-celled, long ellipsoidal, 8–11 × 5–6 u, paraphyses present. (Plate XVI, fig. 2)

Apparently a distinct species, with much smaller spores than other *Phyllachorae* known on *Ocotea*. The small, uniloculate stromata are also characteristic.

On *Ocotea catsbyana*.

FLORIDA: Key Large, coll. M. F. Barrus, deposited at Cornell University herb. *19113*, Mar. 20, 1931 (*type*).

Phyllachora Ciferri Chardon sp. nov.

Maculae amphigena, indeterminata 5–10 mm.; stromata amphigena, parvis, punctiformis, nigris nitidulis; loculis singulis, globosis v. lenticularibus, ad mesophyllum immersis; asci clavatis v. saccatis, cotonis; pedicello breviusculo; sporis inordinatis, hyalinis, granularibus, paraphysis filiformibus.

Spots amphigenous, appearing as discolored, indeterminate areas, 5–100 mm. across; stromata amphigenous, small, punctiform, round, .8 to 1 mm. in diameter, black, shiny, prominent, seldom coalescing but occurring in groups of 3–25 in each spot; locule single in each stroma, globose to lenticular, 210–300 × 150–200 u; immersed in the mesophyll with distinct thick black clypei above and below and heavy stroma on the sides; asci clavate or saccate, 8 spored, 60–85 × 16–21 u, with the pedicill short and the spores biseriate or inordinate; spores hyaline, 1-celled, elliptical, 14–16 × 6–9 u, with a distinct wall and granular contents; paraphyses filiform, very scarce or none. (Plate XV, fig. 2)

This species differs from all other known on *Phoebe* in its conspicuous groups of punctiform stromata and also in its spore measurements. The species is dedicated to the well known mycological explorer Dr. Ciferri.

On *Phoebe montana* (Sw.) Griseb.

SANTO DOMINGO: Sanchez, Peninsula de Samana, Ciferri *4173* (coll. Eckman), April 19, 1930 (*type*).

On *Phoebe* sp.

COSTA RICA: San José, Schmidt *CR 2, 71* and *87* (Bureau Plant. Ind.) 1928–29.

Phyllachora consociata Chardon sp. nov.

Praecedentis etiam affinis sporarum ascorumque fabrica praecipue tamen recedens. Asci non cylindraceis v. vix paraphysatis, sporis ellipticis.

Same macroscopic and stromatal characters as *Ph. Ciferri;* asci 8-spores, cylindrical or cylindrical-clavate, 72–85 × 6–9, with the spores obliquely uniseriate, or partially biseriate; spores hyaline, 1-celled, long elliptical, 9–11.5 × 4.5–5 u; paraphyses inconspicuous.

This peculiar species appeared associated on the same spots as the above; the stromatal characters were the same, but asci and spores different, both in shape and size.

On *Phoebe montana* (Sw.) Griseb.

SANTO DOMINGO: Same *type* specimen as above.

PHYLLACHORA SERJANIICOLA Chardon, Mycologia **13**: 293. 1921.

Phyllachora sapindacearum Stevens, Ill. Biol. Mong. **11**: 39. 1927.

This species was previously known to occur from Porto Rico (the type is Chardon no. *923* from Peñuelas) where it is abundant, and also from a single collection by Kern & Toro (no. *143*) from Macoris, Santo Domingo. All of them are on *Serjania polyphylla* (L.) Radlk.

The Venezuelan material has stromata 2–3 loculate, with locules 175–250 u across, asci clavate, 8-spored, with spores mostly uniseriate, but sometimes partially biseriate; spores ellipsoidal, 10–12 × 6–7 u. Compared with the type specimen it appears to be the same.

The type species of *Ph. sapindacearum* Stevens from Panama has been examined and it appears to be the same as the Porto Rican and Venezuelan material above mentioned. The spores are also ellipsoidal mostly uniseriate in the ascus, 10–12 × 6–7 u. It is therefore considered as a synonym. No doubt, the species has a wider distribution in tropical America. It should not be confused with *Ph. insueta* Sydow, on *Serjania,* reported from Costa Rica and Colombia, which is very different in stromatal and spore characters.

On *Serjania polyphylla* Radlk.

PORTO RICO: Peñuelas, Chardon *923,* July 27, 1920 (*type*); Mayagüez, Stevens *1196,* May 4, 1913; Bayamón, Johnston *1151*, Jan. 1, 1914; Peñuelas, Chardon *896,* Aug. 11, 1920; id. Chardon *1530,* July 1921; Coamo Springs, Britton *3457,* Jan. 5, 1922; Playa Sardinera, Fajardo, Chardon *1554,* Apr. 11, 1922; Cayey, Chardon *1555,* Apr. 15, 1922; Vieques Island, Whetzel, Kern & Toro *2641,* July 17, 1924; Ciales Road, W. K. & T. *2639.*

SANTO DOMINGO: Macoris, Kern & Toro *153,* Mar. 10, 1926.

On *Serjania paniculata.*

VENEZUELA: Monte Bello, near Caracas, Toro *58,* Dec. 11, 1930.

On *Serjania mexicana.*

PANAMA: France Field, Canal Zone, Stevens *1327,* Aug. 24, 1923.

Phyllachora Torrubiae Chardon sp. nov.

Maculae amphigena indeterminatae parum manifestae pallescentes; stromata 20–50, gregaria in circulum disposita, atra nitidula; loculi singulares v. 2–3, globosi, asci paraphysati cylindracei v. cylindraceiclavati. longiuscule tenuiterque pedicellati, sporis inordinatis v. distichis, hyalinis, continuis.

Spots large, irregular, in outline, sometimes spreading over a considerable part of the leaf surface, 1–3 or more cms. across, at first yellow green, then becoming much paler, visible on both sides of the leaf; stromata in groups of 20–50 in each spot, concentrically arranged in the center of the spot, individual stromata amphigenous, roughly circular to irregular thru coalescence, 1–1.5 mm. across or more, black, shiny; locule single or sometimes 2–3, globose or flattened, 220–270 × 180–250 u, lined with thread-like hyphae which fade into a brown, pseudostromatic tissue; clypeus prominent, both above 20–30 u or more thick, extending far beyond the locules; asci cylindrical to cylindrical-clavate, 8 spored, long pedicellate, 90–145 × 12–15 u, with the spores disorderly uniseriate or partially biseriate; spores 1-celled, hyaline, broad navicular or lemon shaped, 14–18 × 6–8 u; paraphyses present. (Plate XV, fig. 4)

The species is typical in the concentric arrangement of the stromata within the spots.

On *Torrubia fragrans* (Dum.) Standl.

PUERTO RICO: Ravine near Quebradillas, Barrus & Chardon *3057*, Dec. 3, 1927; Limestone hills at Peñón, near Ponce, Chardon & Toro *3369*, May 7, 1931 (*type*).

Phyllachora huigraense Chardon sp. nov.

Stromata amphigena, parva, atra; loculi singuli, lenticulares v. ellipsoidei; asci paraphysati, clavati, 60–85 × 13–18 u; sporis inordinatis v. distichis.

Stromata amphigenous, small, about .5–1.0 mm. in diameter, black, approximately circular; locule single, lenticular or ellipsoidal, 300–350 × 175–200 u, surrounded on all sides by black stromatic tissue; asci clavate, 8-spored, 60–65 × 13–18 u, with the spores biseriate or inordinate; spores hyaline, 1-celled, subglobose to broad-elliptical, 9–12 × 6–8 u, with contents finely granular; paraphyses present.

There are two species of *Phyllachora* reported on *Buettneria* in the northern Andean region of South America: *Ph. vallecaucana* Chardon, from Colombia, which has larger, multilocular stromata, with elliptical, uniseriate, spores, 8–10 × 4–5 u (see fig. 12, Jour. Dept. Agric. P. R. **14** *p.* 265); and *Ph. Buettneriae* Stevens from Ecuador, with larger, multiloculate stromata, spores oblong, 10–15 × 10 u. From both of these our species seems to differ: in the small, uniloculate stromata, and in the shape and size of asci and spores.

On *Buettneria parviflora.*

ECUADOR: Vicinity of Huigra, J. N. and G. Rose, Explorations of South America *23305*, Aug. 22, 1918 (*type*).

Phyllachora verrucosa Chardon sp. nov.

Stromata in centro elevato infuscata; loculi 2–5 amphigena; globosi, asci paraphysati, cylindracei, octoni; sporis monostichis, hyalinis, continuis, ellipticeis.

Stromata very conspicuous, amphigenous, pustule-like, forming elevated pustules, raised about .5 mm. above the leaf surface, approximately circular, or irregular, 1–2 mm. across, made up of a black, shiny stroma bordered by any equally elevated host tissue; locules 2–5 in each stroma, facing the epiphyll, nearly globose, 250–320 u across, surrounded on all sides by the dense, black, stromatic tissue, on the hypophyll the stroma is usually fertile, much less elevated above the leaf tissue than in the hypohyll but also black and conspicuous; asci cylindrical, 8-spored, 85–100 × 12–15 u, with the spores uniseriate or partially biseriate; spores hyaline, 1-celled, broad elliptical, 10–13 × 7–9 u, smooth: paraphyses present. (Plate XV, fig. 3)

This is a very characteristic species possessing conspicuous black, pustulate stromata. *Phyllachora Whetzelii* Chardon has spores with the same shape and length, but it does not possess the pustule-like stromata. It is quite possible that *verrucosa* is a form of the species *Whetzelii*, the pustule-like stroma being only a host reaction. A specimen from Porto Rico (Fink no *1598*) seems to be the same but no spores were seen.

On *Eugenia buxifolia* (Sw.) Willd.

HAITI: near Cape Haitien, G. V. Nash *956*, Sept. 4, 1903 (*type*).

On *Eugenia* sp.

PUERTO RICO: Dry hill top south of Yauco, Fink *1598*, Dec. 31, 1915.

PHYLLACHORA EUGENIAE Chardon, Mycologia **19**: 300. 1927.

This is a conspicuous and beautiful species occurring on the dry limestone hills of the south coast of Porto Rico, where the host is quite common. It was known by a single specimen collected by F. L. Stevens, but it has recently been recollected by professor H. H. Whetzel and the writer. In Ekman's specimen from Santo Domingo, the stromata differ from Porto Rico material in that they are scarcely visible in the epiphyll, appearing as tan, circular spots; but in the hypohyll, the black, conspicuous spots are characteristic. Spores uniseriate or biseriate ellipsoidal, small, 8–10 × 4–4.5 u. (Plate XVI, fig. 3)

On *Eugenia rhombea* (Berg.) Krug & Urb.

PORTO RICO: Guanica, Stevens *321*, Feb. 3, 1913 (*type*) Limestone hills near Ponce, Whetzel & Chardon *3291*, May 23, 1931.

SANTO DOMINGO: Las Lagunas, Prov. Santiago, Ciferri *4250,* (coll. E. L. Ekman) Nov. 21, 1930.

PHYLLACHORA WINTERI Sacc. & Syd., Syll. Fung. **14**: 673.
Ph. Xanthoxyli Wint. not (Lev.) Cke, Hedwigia **26**: 34. 1887.
Physalospora tijucensis Rehm, Hedwigia **40**: 111. 1901.
Trabutia Xanthoxyli Chardon, Sci. Survey Porto Rico **8**: 55. 1926.

This is a difficult species to understand on account of its confusing nomenclature. *Phyllachora Xanthoxyli* (Lev.) Cooke from Java, the type of which is deposited in the Paris Museum, according to Theissen und Sydow (p. 515) looks the same, but has larger spores, 21–23 × 5–5.5 u. Winter's specific name *Xanthoxyli* is untenable and was changed to *Winteri;* most of the tropical American collections have been referred to this specific name. An examination of the type of *Ph. brasiliensis* Speg. shows asci and spores very much like *Winteri* in shape and measurements but the stromata are scattered and individual, not tending to coalesce.

A cross section thru a typical *Ph. Winteri* generally shows a subcuticular stroma, like a *Trabutia,* but occasionally a few stromata are found extending to the hypophyll and thus the fungus is retained in *Phyllachora.* The species *Trabutia Xanthoxyli* Chardon should be included as a synonym. The species is widely distributed in tropical America.

On *Xanthoxylon* sp.

BRASIL: Sta. Catharina, Rabh. F. europ. *3558* (*type* of *Ph. Winteri*); Tijuca, Rio de Janeiro, Ule *2258* (*type* of *Ph. tijucensis*); Sao Leopoldo, Rick *379,* 1908 (comm. by A. J. Stevenson).

VENEZUELA: Near Ocumare, Toro *115,* Dec. 1930 (occurring with *Ph. applanata*).

COSTA RICA: Near San José, Schmidt *CR 66* & *77* (Bu. Plant Ind.) 1928–29.

On *Xanthoxylon martinicensis* (Lam.) D. C.

PUERTO RICO: Whetzel & Olive *649,* Apr. 19, 1916 (type of *Trabutia Xanthoxyli*).

SANTO DOMINGO: Sánchez, Prov. Samaná, Ciferri *4548* (coll. Ekman), Apr. 19, 1930.

ENDODOTHELLA PICRAMNIAE (Sydow) Theiss & Syd., Ann. Mycol. **13**: 590. 1915.
Dothidella Picramniae Sydow, Ann. Mycol. **11**: 266. 1913.
Phyllachora Picramniae Stevens, Ill. Biol. Monog. **11**: 38. 1927.

The type species has been examined and the 2-celled spores clearly observed in a few asci. Most of the spores, however, are unicellular,

a fact which has brought about confusion among investigators. Stevens' type of *Phyllachora Picramniae,* was examined: the spores are non-septate and it seems to be an immature form of the above. They measure 20–26 × 5–6 u. The species has beautiful, conspicuous, circular stromata. It seems to be common in Costa Rica.

On *Picramnia bonplandiana* Tul.

COSTA RICA: Rio Virilla, Sydow f. exot. exs. *134* (coll. A. Tonduz) Oct. 11, 1912 (*type* of *Dothidella Picramniae* Sydow); Aserri, Stevens *119,* June 26, 1923 (*type* of *Ph. Picramniae* Stev.); near San José, Schmidt *32, 38, 72* & *78* (Bu. Plant Ind.) 1928–29; Vicinity of San Sebastián, south of San José, Bureau of Plant Ind. *49352* (coll. P. C. Standley) Feb. 23, 1926.

Genus SHAERODOTHIS Shear Mycologia **1**:162. 1909.

Like PHYLLACHORA; spores one-celled, brown; paraphyses brown.

According to Shear (loc. cit.) *Sphaerodothis* was the name proposed by Saccardo and Sydow (**4**) for a subgenus of *Auerswaldia* to include the single species *A. Arengae* Rac. Shear raised it to generic rank to take care of species like Phyllachora having brown spores. Theissen und Sydow (**13**) recognized the genus and include seven species under it; three of which are from Tropical America.

The brown color of the spores, which distinguishes this genus from *Phyllachora* is a variable factor which is difficult to depend upon as a sharp basis for generic differentiation. In *Sph. portoricensis* and *Sph. luquillensis* the change of color of the spores is shown in full process of evolution. In both species, the spores in the young stage are large, hyaline to bluish, and full of granular contents and oil drops; in maturity they shrink to a smaller size (see spore measurements in the diagnosis of both species) and change to an olive brown color.

Occasionally, spores of true *Phyllachora* exhibit a few spores which are faintly brownish. Such is the case reported by Stevens (**7**) in *Phyllachora Scleriae* and *Ph. sphaerosperma,* which he changes as new combinations to *Sphaerodothis.* The writer has examined carefully many specimens of these from various countries and he has not been able to find a single spore which is distinctly brown. Admitting that a few of them are occasionally brownish, their rarity is such as to have escaped the attention of other mycologists, and both species should probably belong better in *Phyllachora* where they have always been.

Sphaerodothis trinitensis Chardon sp. nov.

Stromata epiphylla, linearia, atra; loculi singulis, lenticularibus, clypei superne; asci paraphysati, clavati, sporis inordinatis, fuscis, continuis.

Stromata epiphyllous, linear, black, 1–2 mm. long × .6–1.0 mm. wide; locule single, lenticular, 200–260 × 60–100 u, with a thick, black clypeus above, and little or no stromatic tissue on the sides or below; asci saccate or clavate, 8-spored, 46–56 × 14–16, with the spores inordinate; spores distinctly brown, 1-celled, long elliptical to navicular, 14–18 × 5–7 u, paraphyses present.

The species is distinctly a *Sphaerodothis* apparently undescribed heretofore.

On *Schizachyrium condensatum.*

TRINIDAD: Seaver *3113*, 1921 (*type*).

Sphaerodothis portoricensis Chardon spec. nov.

Stromata amphigenae, determinatae, atra pallescentes, loculi 1–2, asci paraphysatis, cylindraceis v. clavatis; sporis distichis ellipsoideis.

Stromata amphigenous, conspicuous, equally visible on both surfaces of the leaf, black, not shiny, markedly convex, 2 mm. long × 1 mm. wide, single, surrounded by a distinct zone of yellow tissue, 1 mm. wide on the sides and about 2 mm. long on each end of the stromata, seldom arranged in linear rows and coalescing to form stromata, 3–5 mm. long, and then causing yellow longitudinal streaks; locules 1–2 in cross section, globose or slightly angular on the adjacent sides, 180–250 × 100–135 u, immersed within the stroma and in the mesophyll; asci cylindrical clavate, 8-spored, with the spores biseriate in the main body of the ascus, 90–100 × 16–21 u; spores 1-celled, large at first, long ellipsoidal, 22–26 × 10–12 u, with distinctly granular contents, at maturity reducing in size, navicular, 18–21 × 7–8 u, with uniform olive brown contents; paraphyses present.

This species is close to *Phyllachora Guaduae* Chardon, reported by the writer from Colombia on *Guadua latifolia* Kunth, but falls under *Sphaerodothis* on account of the olive-brown contents of the spores. It is also close to *Sphaerodothis antioquensis* Chardon, on *Arthrostylidium* from Antioquia, Colombia, but differs from it in having a compound fructification, navicular (not elliptical, blunt) spores and contents light olive-brown. The reduction in the size of the spores occur as they approach maturity, and the change which has also been observed for *Sphaerodothis luquillensis* Chardon (1) collected by the writer, on the slopes of the Luquillo Mountains. Stevens no. *4388* collected in Utuado, P. R., on the same host, is also to be referred to this species.

On *Arthrostylidium sarmentosum* Pilger.

PUERTO RICO: Trail from forest cabin to El Yunque, Luquillo Mountains, Chardon *3368,* Mar. 29–30, 1930 (*type*); Utuado, Stevens *4388,* Nov. 8, 1913.

Dictyochorina Chardon gen. nov. (Phyllachoracearum).

Stromata biophila innata, asci paraphysati octospori; sporae triseptatae, muriformiae, hyalinae.

Stromata between the epidermis and the mesophyll; asci cylindrical to cylindrical-clavate, 8-spored; spores 3-septate, with the two central cells sometimes provided with cross-partitions, making the spore muriform, hyaline; paraphyses present. Type species: *Dictyochorina Arundinellae* sp. nov.

This genus is erected to take care of the species like *Dictyochorella,* having muriform, hyaline spores. In this latter genus, the spores are muriform, brown. No genus is known to receive the species with hyaline spores and the necessity for its erection is necessary to take care of the two species described below.

Dictyochorina Arundinellae Chardon sp. nov.

Stromata amphigena, parva, atra, convexula linearia; loculi sat numerosi irregulares, asci paraphysati, cylindracei clavati, octoni; sporis inordinatis, triseptatis, muriformibus.

Stromata small, black, slightly raised in the epiphyll, much less visible and flat in the undersurface, linear, about .5 to .8 mm. long and much less so in width, arranged in linear groups of 15–40 stromata, about 1.0–1.5 cm. long and 2–3 mm. wide, which makes them conspicuous, each small stromata unilocular, but by frequent coalescence appearing multilocular; locules flat globose, or angular thru pressure, with heavy black clypeus bordering its top and much less so on the sides 160–260 × 100–180 u; asci cylindrical-clavate, 8-spored, 68–85 × 10–14 u, with the spores inordinate; spores long ellipsoidal, 17–21 × 6–8 u; muriform, hyaline, with 3 septae and the two central cells subdivided transversely by cross partitions; paraphyses present. (Plate XVI, fig. 1)

On *Arundinella martinicensis* Griseb.

PUERTO RICO: Hacienda Miramontes, Cidra, Chardon *1716*, Feb. 15, 1931 (*type*) Mayagüez, Whetzel & Olive *553,* Mar. 7, 1916.

GUATEMALA: Los Amates, Dept. Izabal, Bureau Plant Ind. *60867* (coll. W. A. Kellermann), Mar. 15, 1905.

The specimen from Guatemala is labelled "on *Imperata contracta*" but this seems to be an error in the host determination. The asci and spores agree with the Porto Rico type, and the host appears to be the same.

Dictyochorina portoricensis Chardon sp. nov.

Stromata amphigena, atra, nitidula, colliculosa; loculli 2–5; asci

apice obtuse rotundati subcrassiuscule tunicati, basi breviter pedicellati, octospori; sporis muriformibus, 4–6 septatis, paraphysis filiformibus.

Stromata amphigenous, approximately circular, about 1.0–1.5 mm. in diameter, black, shiny, not prominent, but with both surfaces slightly rugose with the small ostiola, scattered, not confluent, surrounded by a thin zone of raised, dead host tissue, not over .5 mm. across; locules 2–3 (seldom 5) globose or approximately so, 180–300 × 165–240, immersed in the mesophyll, with heavy black clypei above and below, and stromatic tissue on the sides; asci clavate, 8 spored, 70–81 × 22–27, with short pedicell, ascus wall greatly thickened at the round apex (10–14 u across), muriform, hyaline, tapering on one end, with 4–6 septate and 1–3 cross walls; paraphyses filiform, inconspicuous. (Plate XVI, fig 4)

This species is evidently Phyllachoraceous in stromatal characters, but the muriform hyaline spores makes it fall under our new genus *Dictyochorina*. It is known only from the type locality.

On *Eugenia axillaris* (Sw.) Willd.

PUERTO RICO: Hacienda Pulgillas, Coamo, Chardon *902*, Aug. 26, 1920 (*type*).

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EXPLANATION OF PLATES

PLATE XIV

(All photographs reduced to two thirds natural size)

Fig. 1. *Trabutia brasiliensis* (Speg.) Chardon, a portion of Spegazzini's type. Puiggari No. *1488* from Apiahy, Brasil.

Fig. 2. *Phyllachora tetraspora* Chardon, a portion of type, Ciferri No. *4554*, from Hato del Yaque, Santo Domingo.

Fig. 3. *Phyllachora Noblei* Chardon, leaves from Chardon *3512*, Bayamón-Toa road, Porto Rico.

Fig. 4. *Trabutia Basanacanthae* Chardon, type coll. by Rick, Bureau Plant Ind. *66619*, Parecy, Brasil.

Fig. 6. ***Catacauma Puiggarii*** **(Speg.)** (Chardon, portion of Spegazzini's type. Puiggari *2770* from Apiahy, Brasil.

Fig. 7. *Phyllachora Kyllingae* Chardon, Schmidt *CR 28*, San José, Costa Rica (type).

PLATE XV

Fig. 1. *Catacauma venezuelensis* (Sydow) Chardon, portion of type, Sydow *830*, Puerto La Cruz, Venezuela.

Fig. 2. *Phyllachora Ciferri* Chardon, portion of type, Ciferri *4173*, coll. Ekman, Sanchez, Santo Domingo.

Fig. 3. *Phyllachora verrucosa* Chardon, portion of type, Nash *956*, Cap Haitien, Haiti.

Fig. 4. *Phyllachora Torrubiae* Chardon, portion of Chardon & Toro *3369*, Ponce, Porto Rico.

PLATE XVI

Fig. 1. *Dictyochorina Arundinellae* Chardon, portion of type, Chardon *1716*, Cidra, Porto Rico.

Fig. 2. *Phyllachora Catsbyanae* Chardon, portion of type, Barrus *19113* (Cornell), Key Largo, Florida.

Fig. 3. *Phyllachora Eugeniae* Chardon, portion of Ciferri No. *4250*, coll. Ekman, Las Lagunas, Santo Domingo.

Fig. 4. *Dictyochorina portoricensis* Chardon, portion of type, Chardon *902*, Coamo, Porto Rico.

PLATE XIV

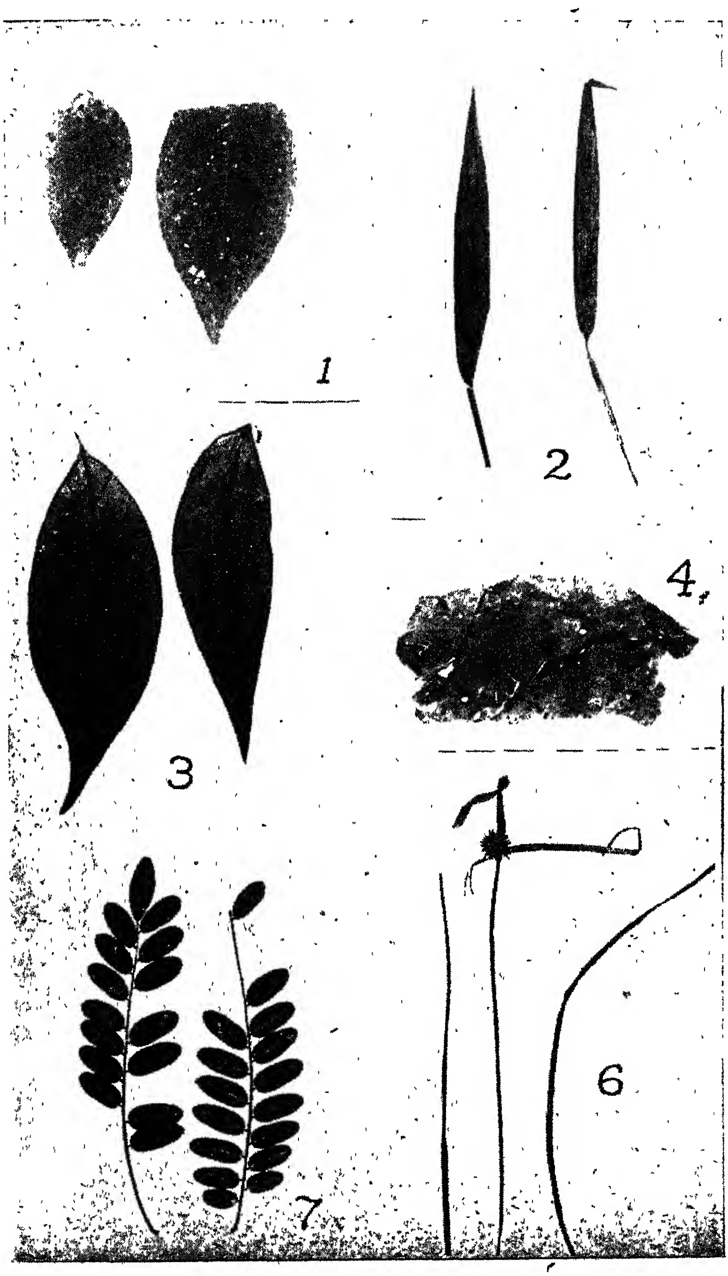


PLATE XV

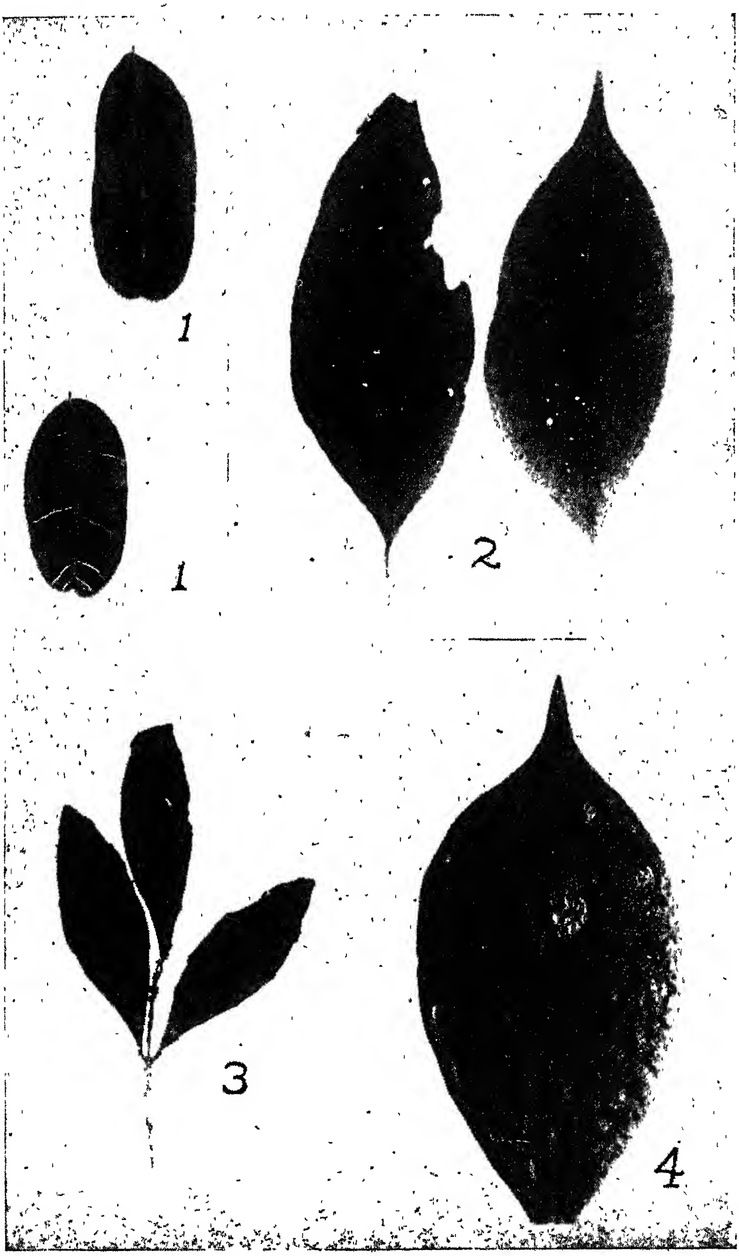
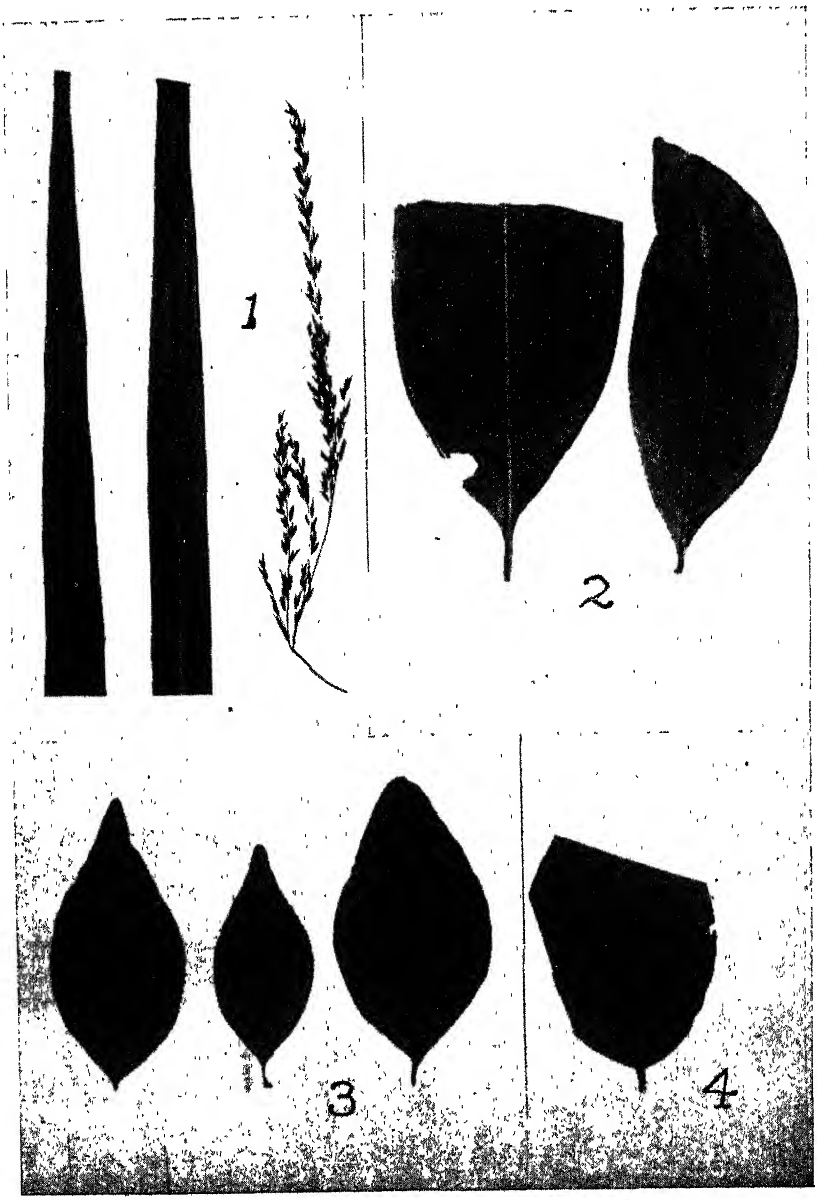


PLATE XVI



THE BROWN ROT FUNGUS IN PUERTO RICO [1]

Jaime R. Guiscafré

(With one plate and one figure in the text)

Introduction

Inasmuch as there are various causes of disease in Citrus in which a gum exudate in the trunk is a characteristic symptom; the term brown rot, as has been applied to the *Phytophthora (Pythiacystis)* type of gummosis has been selected as the most proper for the disease here reported. Mal-di-gomma or foot root rot also attacks the trunk and branches while other two forms of gummosis common in Porto Rico, grapefruit gummosis and psorosis of oranges, may exhibit similar symptoms.

The disease here reported was for the first time found on affected groves at the Eugenia plantation, near Añasco, while endeavoring to discover the possible causes of gum disease in Citrus. While mal-di-gomma is very prevalent in that region, the *Phytophthora* rot plays no minor part in the havocs caused by the gum-type symptoms of disease. A preliminary report of this work has already been published by the writer and the present paper presents the results obtained in the studies of the disease.

The writer wishes to express his appreciation to Professor Rafael A. Toro, under whose direction the work was done, for suggestion of the problem, reading and correction of the proof and for invaluable aid and encouragement.

Suscepts

PLANTS AFFECTED

Brown rot appears to be an important disease of the genus *Citrus*.

VARIETAL SUSCEPTIBILITY

The sour orange, (*C. Aurantium*) is the most resistant variety. In many cases the wounded tissues of orange trees have healed rapidly and the fungous growth being checked. The common lemon (*C. Limonum*) and the West India Lime (*C. aurantifolia*) are highly susceptible. The sweet orange (*C. sinensis*) and grapefruit (*C. grandis*) are between the highly susceptible *C. aurantifolia* and the very resis-

[1] Contribution from the Department of Botany, and Plant Pathology No. 1, College of Agriculture and Mechanic Arts, University of Porto Rico. Publication authorized by the Chancellor.

tant species, *C. Aurantium.* No case has been reported of the disease occurring in the mandarin (*C. nobilis*) while, according to T. Fahmy, citron (*C. Medica*) is quite susceptible. Citron is the most common stock used in Egypt. The sweet lime (*C. Limetta*) was found to be susceptible in Palestine, where recently 20 per cent of Jaffa oranges, budded on sweet lime stock, were killed. The author also had the opportunity of observing a severe case of brown rot in the wild grapefruit tree (*C. maxima*) found in a coffee plantation at Mayagüez.

THE DISEASE

NAME.-

The disease is known by several names. Due to the fact that the causal fungus cause brown rot in lemons, it is generally called brown rot. It is also known as gummosis, but this is not a very appropriate term for the disease, since other several causes may contribute to this symptom.

HISTORY AND RANGE

In the early literature on citrus diseases there are many reports from different citrus-producing districts on the occurrence of gum exudates and gum diseases, but the forms reported are not accurately described: therefore, it is difficult to identify the causal agent.

The earliest serious outbreak of gummosis, occurred in the Azores Islands in the year 1834; although Ferrari in 1646 and Sterbeek in 1682 had already reported milder cases of the disease. Fouque (1873), referring to this destructive outbreak in the Azores Islands said that "sweet-orange trees 200 to 300 years of age which were producing 6,000 to 20,000 oranges a piece, were found to be affected by a serious form of gummosis. The trees put on heavy crops of fruits and the leaves turned yellow and fell off in great quantities".

Gum disease was reported from Italy between 1862 and 1878, by Savastano, Reggio and others. It was reported from the Balearic Islands (Spain) in 1871. Very recently it was reported in the orient by Reinking (1921) and Lee (1925). In 1885 it was reported from New Zealand by Kirk and from Cape Colony, South Africa in 1891. Gummosis made its appearance in California in the year 1875 and in Florida in 1876. Garey states that gummosis was the most serious epidemy of 1878; for this reason common lemon, lime and citron stocks were no longer used, and the sour orange was unanimously adopted, due to its high resistance. Outside from the United States, it has been reported from Cuba by Cook (1906) and Cook and Horne

(1908); from Brazil by Averna-Sacca (1917); from Mexico by Gándara (1910); from Paraguay by Bertoni (1911). It was not until 1918 that the disease was reported from Porto Rico by Stevenson.

Since the disease made its appearance, investigators from different localities, have stated their opinion as to the causative agent. Briosi (1878) who studied the disease in Italy, described a fungus *Fusarium limoni*, associated with gummosis; his description being very similar to that for *Phytophthora citrophthora*. In 1891, Comes from Italy, also produced gum by inoculation with a bacterial species called *Bacterium gummosis*. Swingle and Webber (1896) considered the gum disease as infectious and caused by organisms invading the bark. Fawcett and Burger (1911) and Fawcett (1912 *c*, 1913 *a*) showed that a fungus similar to *Diplodia natalensis* produced gumming of branches.

Other investigators have concluded that gum diseases in *Citrus* are due not to organism, but to certain external stimulus against the affected region. Among these Sorauer (1872) in Germany and Prillieux (1874) in France, were the first to arrive at this conclusion, as a result of their work as to the cause of gum in the genus *Prunus*, the two genera being closely related. But Savastano, after working with both genera concluded that gummosis in *Citrus* is due largely to wounds or traumatisms. In recent years, Savastano has modified his earlier view recognizing that there is a gummosis formed as a result of the response of the tree to some external stimulus, and that there is another one caused by specific organism.

Importance

Brown rot is a serious disease of citrus fruits. During the first months, the lesions are rather few and of relatively small area; in no way impairing the vigor of the tree. As the lesions extend into the branches of the trees, the folliage begins to be partially affected. In the last stages the lesions are so great that they really girdle the tree, causing the yellowing of leaves and finally defoliation. The lesions destroy the food-conducting vessels of the tree, affecting the leaves and fruits. The fruits remain undersize, ripen very late in the season, and the rind takes a dirty brown color.

The disease was so serious in California in 1878, that Garey (1882) referred to it as the only important disease at that time. When it appeared in the lemon trees in California, the industry was greatly injured, because not only was the orchard affected, but also the fruit spoiled after being packed. In the fruit the disease is called brown rot and it is readily transmitted by contact. The causal organism

produces no spores in the fruit, but the disease is readily transmitted by pieces of mycelium of the fungus.

There is no accurate estimation of the economical importance of the disease in lemons in California, but during the first year, following its appearance, it caused great losses, both in the orchard and in the market.

Nobody has estimated the losses due to the disease in Porto Rico, but a visit to the Eugenia Grove, a few kilometers from the town of Añasco, showed that the disease is of great importance. There are areas in which many trees are seriously affected; in others, however, young trees have been planted where the old ones died, and these trees are also affected, and producing fruits undesirable for the market. The fruit of affected trees is coarse, of dirty brown coloration, sour and insipid.

Symptomatology

MORPHOLOGIC SYMPTOMS

The pathogene, generally affects the base of the trunk, and then works upwards, the lesions being always greater in length than in width. The bark is killed in patches accompanied by the exudation of gum, but the injury is not superficial, but rather deep, the cambium being included always in the affected region. In other kinds of gummosis, such as *Botrytis gummosis,* the bark is softened. In brown rot gummosis, the bark remains hard until it is dry and then it cracks longitudinally. The exudation of gum, has been thought to be a physiological product of the reaction of the cells to protect the tree from rot-producing organisms. In resistant stocks, however, the lesions are self-limited, being a few inches long and wide, but on the susceptible species the author measured lesions of even 15 inches in length and 5–7 inches wide. As the disease progresses, the leaves on the side of the branches more seriously affected, begin to turn yellow, and finally die and fall. Superficially, the exudated gum is the most characteristical symptom of the disease. If the bark is removed, there is a more or less definite boundary between the sound and the infected area; this boundary being characterized by a light brown shaded area.

The bark at this time is yet firm, only the color is changed, from a pale normal green to a light brownish shade. The gum was observed to be formed near the cambium, in pockets 1 to 2 inches deep. The gum at the place of origin, is watery and clearer, while when coming through the bark, it becomes dark brownish red and denser. Later it turns dark brown, and becomes brittle due to the loss of

water. The gum is deposited in oval masses, on the bark or follows the contour of the longitudinal cracks. In the last stages of the disease, the bark shrinks and cracks, leaving a surface covered with hardened gum, thus protecting to some extent the inner tissues from the invading rotting fungi. In the fruit the fungous causes a brown discoloration which gradually involves a great area of the rind. Sometimes gum exudates from the center of the spot.

SIGNS

Only in the laboratory are the characteristic signs of the disease showed.

HISTOLOGIC SYMPTOMS

Tissue from the bark was not examined for histological symptoms. Sections from rind of infected fruits of the Mexican Lime (*C. aurantifolia*) were made and occasionally observed. The mycelium grows in thick masses in the lemon rind and is formed both intra and extracellularly. Disintegration of the cell wall was observed after few days of inoculation. A brown color was developed all around the place of inoculation.

ETIOLOGY

NAME HISTORY AND CLASSIFICATION OF THE PATHOGENE

The organism was first isolated from diseased lemon trees, in California and named *Pythiacystis citrophthora* by Smith. Wilson unable to find any reproductive bodies suggested that the fungus be classified under sterile mycelium forms, while Leonian, after a physiological study of several species of the genus *Phytophthora* found that *Pythiacystis citrophthora* Sm. and Sm., was a *Phytophthora* and transfer the species to that genus. The organism is known to-day as *Phytophthora citrophthora* (Sm. & Sm.) Leonian.

PATHOGENICITY

Fawcett found that inoculation into sound trees with bits of diseased tissue transmitted the disease with all its characteristic symptoms; but, however, only diseased tissue from the marginal fringe of the killed bark of active lesions was capable of transmitting the disease. He also made inoculations with bits of lemon fruits affected with brown rot and produced the disease. The author, after isolating the fungus from diseased trees, inoculated ripen lemons, and the characteristic brown rot was produced. Reisolation proved the fungus causing it identical to that found in the diseased trees.

LIFE HISTORY

The life history of the fungus is very simple.

When the soil is wet the mycelium is capable of producing sporangia and spores. If dry periods follow, the sporangia remained in a resting stage until favorable conditions return; however, during this time the fungus reproduces by means of pieces of its mycelium, and the disease is transmitted easily to the bark and fruits.

During wet seasons, the sporangia, which are produced in the soil, discharges biciliate motile spores which swim about, reach the bark, or fruit lying close to the ground and readily germinate, producing mycelium again. The organisms do not produce sporangia either in the bark or in the fruit. All attempts to find the sexual stage of the organism have failed. The author observed structures similar to what should be the sexual stage, but there were not convincely of their identity.

Pathogenesis

INOCULATION

The main sources of inoculation are the mycelium found in the soil, bark and fruits, and the spores which are only found in soil. Chlamydospores are also found on the soil and serve as inoculon.

According to Fawcett, the period of inoculation of the fungus varies. With several inoculations he produced the characteristic disease after four months, in other instances, after six months. He recorded the death of a lemon tree after eighteen months from inoculation.

SAPROGENESIS

Phytophthora citrophthora lives saprophytically in the soil debris only and here produces spores and chlamydospores.

INOCULATION

The sporangia, chlamydospores and mycelium are carried by the water to different places of the orchard and the spattering rains, tools and animals will probably transport them and infect the sound trees.

Characteristics of the Fungus

Four different culture media were used to study the fungus. These were: corn-meal agar, corn-meal agar plus 5 per cent citric acid, moist clay soil and Cook II media. Sporangia could not be produced in any of these media; even all trials with the moist clay

soil failed to produce sporangia. The organism grew more luxuriantly at room temperature from 77°F average, in the corn-meal agar plus 5 per cent citric acid. Twenty-four hours after inoculation the fungus grew about ¼ inch, concentrically; at 48 hours was 1 inch; at 72 hours, 2 inches; at four days all the petri dish was covered with mycelium. Cultures after four weeks old turned to an ashy color. The mycelium is non-septate, profusely branched and cottony. In young cultures it is pure white, but as the culture becomes old it turns gray and ashy. The author examined the solid cultures daily and no sporangia were noticed from the first day of inoculation to six-week-old cultures, which were then left aside. The material was obtained from diseased trees in the Eugenia Grove, near the town of Añasco.

Material from different parts of the tree was tried in the following way: diseased tissue from the lesions and from 6 inches and one foot away from the lesion, respectively, were used. In no instance the tissue from itself produced the fungus, but only the material gathered from 6 inches and 1 foot away produced the characteristic mycelium.

After the writer failed to obtain sporangia from wet-soil cultures, a new method was developed. This method consisted in concentrating the corn-meal agar in the center of the petri dish forming a round mass of about 2 inches in diameter and ¼ inch thick, leaving a margin between this mass and the petri dish of ¾ inch. In this place, sterile water was poured. An inoculation was made with a bit of the mycelium in the center of the mass and from then on, the culture was examined daily. After 5 weeks, when the water became slimy, sporangia were abundantly produced. Continued examination showed that 6–7 weeks the sporangia became scarce while a flush of chlamydospores and conidia were conspicuously abundant. The sporangia observed were lemon-shaped, in some cases elongated while in others more rounded with a protuberance at the tip. Intercalary sporangia were found in some occasions and sporangia with two pores were observed. They showed a wide range in size and shape, but in the average they were 8 u long and 6 u wide. The chlamydospores range from well-rounded ones to elongated and averaged 6 u in diameter. Spores were seen germinating and they were of approximately the same size as the chlamydospores. The sporangiophores were rather short: 2 u in length, but there were some which attained 16 and 18 u.

In the first attempts to isolate, the organism always an infection of a *Fusarium* species was present; according to Fawcett the secondary infection of the *Fusarium* species slightly increases the injury of

P. citrophthora. The only way of getting rid of this secondary infection was by inoculating healthy lemon fruits with the mixed culture after which *P. citrophthora* remained alone in the inoculated lemons, isolating from this the fungus in pure cultures.

Epiphytology

Gummosis caused by *P. citrophthora* needs several factors in order to develop in an orchard. The factor of prime importance is moisture, the secondary ones being: injuries, favorable temperature and the resistance or susceptibility of the stock used. The injuries of any nature are not essential for the rapid development of the disease; whenever moisture and favorable temperature prevail, the fungus enters the bark easily.

Moisture is the essential factor for spreading the disease. For example, in the Eugenia Grove, the trees are budded low, it rains abundantly, from 70 to 80 inches annually and the water table is often found at 1 to 1½ foot below the surface. This is a favorable place for the development of the disease.

Control

prevention

In all diseases, the methods for prevention are the cheapest and most easily carried out, but they are often neglected by the growers. There has been formulated some very good methods for the prevention of gummosis. These are: (1) plant the trees in mounds, in this way the tree will have its roots well exposed and, therefore, afford less chance for the development of the disease; (2) by avoiding injuries of any sort to the bark or crown roots; (3) providing a good drainage system, and, finally, (4) used, where possible, resistant stocks such as sour oranges.

Other methods are: paint the basal part with Bordeaux paste, and, in places where irrigation water is used, dig the soil among the main roots and leave a circular ridge around the tree.

Another method which has proved very successful is tree surgery. This consists in scraping the bark slightly to see the extent of the infection. Then the "invaded area", or brownish zones, is dessected out with a heavy knife cutting thru the wood about ½ to 1 inch beyond the invaded zone on the sides and from 1 to 2 inches beyond both at top and bottom. The cut above and below are made at an acute angle. Then the wound is desinfected by any of the commercial desinfectants such as Bordeaux paste, using 1 pound copper sul-

fate and 2 pounds rock lime to 1½ gallons of water. Protexol may be used also. After this treatment, the purpose of which is to kill spores or mycelium present, the wound is painted.

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Explanation of Plates

PLATE XVII

Grapefruit trees at Hacienda Eugenia showing effects of *Phytophthora citriphora* infection.

PLATE XVIII

A.—The mycelium showing its non-septate condition and its habitual way of branching.

B.—Usual type of sporangia at several stages of development.

C.—Sporangia and chlamydospores showing their characteristic forms and shapes.

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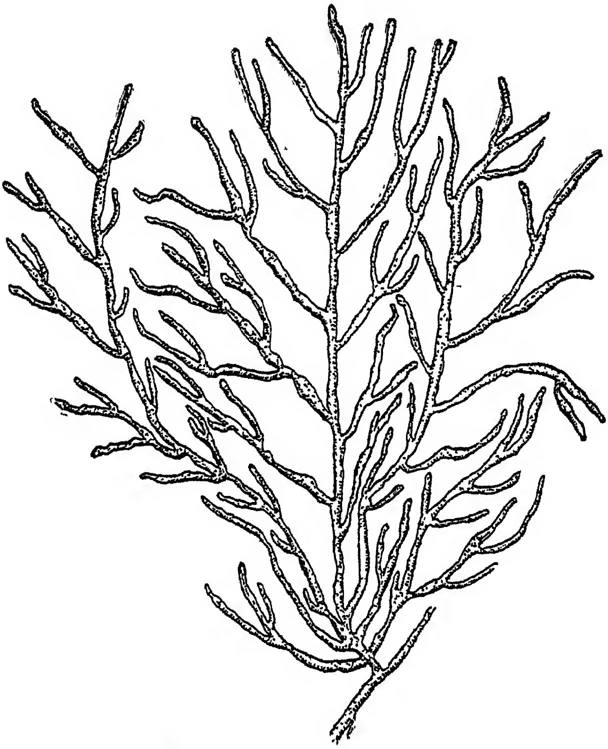
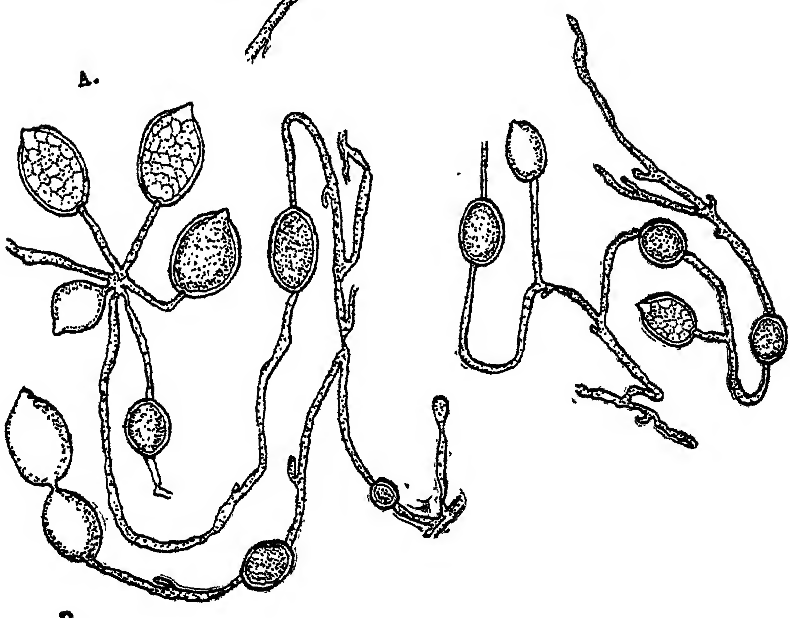
PLATE XVII

PLATE XVIII



A.



B.

THE DAMPING OFF OF TOBACCO AND ITS CONTROL IN PUERTO RICO

By J. A. B. Nolla, B.S.A., M.S.

The paper deals with a very severe disease of tobacco seedlings in Puerto Rico, two organisms, *Pythium debaryanum* and *Phytopthora Parasitica* var. *nicotinae* having been found to be causal agents.

The symptoms produced by two pathogens are very similar and are mainly of the necrotic type. Small seedlings when affected usually rot completely while larger seedlings may show other symptoms. On the latter, small, lens-shaped or elongated lesions, or large necrotic areas which often cause the girdling of the stems, are evident. Affected seedlings occasionally send out roots above the lesions in an effort to recover. If infected with *Pythium debaryanum* such seedlings may develop into normal plants when transplanted, but if the lesions are produced by *P. Parasitica,* death takes place within a short time after transplanting. In infections by *P. Parasitica,* a leaf spot is usually part of the symptomological picture.

Of the environmental factors which favor the spread and severity of the disease, probably the most important is moisture; while temperature, not being a very variable factor in Porto Rico, at least below the limits which might hinder the development of the pathogens, seems to be of less significance. When adequate moisture relations are maintained, the disease appears to be equally severe during all seasons of the year. It is maintained that the disease spreads very rapidly and with great severity in thickly sown beds.

The known methods of eradication and protection for this disease and their merits in Puerto Rico are discussed.

The spread of the disease may be checked in some instances of light infection by drenching diseased areas with a 1 to 30 formaldehyde solution, but it is clear that protection can not be afforded by this means when the spores of the fungous agents have been disseminated by surface currents or drainage water prior to the treatment.

For tobacco seed-beds a successful fungicide or soil disinfestant should be of continued action and should either eradicate the pathogens from the soil or protect the seedlings from infection up to the time of transplanting. Formaldehyde and steam disinfestation are effective methods when reinfestation is prevented. Their use in

Puerto Rico is not practicable because of the high cost of application and because in that island the system of seed-beds is such that reinfestation can not be prevented.

In experiments under controlled conditions, copper stereate, Uspulun, Bayer dust, copper sulfate, copper flousilicate and acetic acid have proven to be ineffective in controlling the disease. Trials with Corona copper carbonate (about 20 per cent metallic copper) at different rates of application show that fairly satisfactory eradication and protection is afforded with two applications of four grams of the dust, one a week before sowing the seed, the other two weeks after germination. In field trials when the dust is applied after the disease has started, the treatment is ineffective.

Experiments with Bordeaux mixture (4–4–50 and 5–5–50) have proven the effectiveness of this fungicide as a soil disinfestant for damping-off in tobacco. Two applications should be made, one a week before sowing the seed, and another two weeks after germination, the rate of application being one-half gallon of the mixture for every square foot of bed surface.

When copper fungicides are applied to the soil on beds soon after a crop of seedlings has been grown, injury to seedlings of the second crop results. Such injury does not occur when the chemicals are applied to a soil which has not previously grown tobacco. The injury results in imperfect germination, and in yellowing, stunting and a defective root system of the seedlings. Such a condition is attributable to indirect action of the copper compounds which may either react with substances excreted into the soil by the seedlings of the preceding crop, or may affect the soil flora in a deleterious way. A hindrance of the activities and development of the beneficial soil microorganisms may cause starvation of the seedlings.

THIELAVIOPSIS PARADOXA; AN IMPORTANT DISEASE OF SUGAR CANE

By MELVILLE T. COOK, *Plant Pathologist,*
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The rotting of seed cuttings of sugar cane, caused by this fungus led to the studies which are recorded in this paper. A review of the literature shows that poor germination of seed cuttings of sugar cane have been studied in other parts of the world and have been attributed to many causes, such as *Colletotrichum falcatum* in Louisiana and India, to *Marasmius plicatus* in Louisiana, to *Marasmius sacchari* in Puerto Rico, to *Ceratostomaella adiposum* in India, to *Lasiodiplodia theobromae* in Philippine Islands and *Thielaiopsis paradoxa* in many places.

The first record of this fungus was not from the tropics but from France where it was described by De Seyenes in 1886 under the name of *Sporoschisma paradoxum.* In 1892 Saccardo gave it the name of *Chalara paradoxa* (De Seyenes) Sacc.

In 1893 it was reported from Java by Went under the name of *Thielaviopsis ethacetica,* by which it is known in much of the literature. He also gave it the common name of pineapple fungus because it produced an odor in the decaying cane similar to ripe pineapples. This is the first record of the fungus in the tropics and the first record of its attacking cane that has come to the attention of the writer. In 1904 von Höhnel recognized the fungus described by Went was the same as the one described by De Seyenes and made the new combination *Thielaviopsis paradoxa* (De Seyenes) Von Höhnel. In 1928 Dade reported the results of studies on a fungus on the Gold Coast of Africa and the finding of what he believed to be the perfect stage. As a result of these studies he made the new combination of *Ceratostomaella paradoxa* (De Seyenes) Dade. In consideration of the fact that the predominant stage of the fungus is *Thielaviopsis paradoxa,* the writer will use that name.

The fungus has a very wide geographical distribution and attacks a large number of plants, including areca palm, oil palm, date palm, coconut palm, pineapple and banana.

In 1893 Massee published a paper "On *Trichosphaeria sacchari,* Mass., A fungus Causing a Disease of Sugar Cane", as a result of studies on material received from the British West Indies. The text

of this paper indicates that the author confused two or more species in his description and some of his drawings are evidently of *T. paradoxa*. A part of his description of the behavior of the fungus corresponds very well to that of *T. paradoxa*. He says,—

"Although a true parasite, in the sense of destroying perfectly healthy, living tissue, the fungus almost invariably commences as a saprophyte, the conidia germinating on the remains of dead leaf-bases scars formed by broken lateral branches, roots &c., the hyphae afterwards passing into the living, uninjured tissue of the cane; and judging from the fact that the disease is always most mature at the lower and older portions of the cane, it is evident that the fungus effects an entry by the means indicated. The cultures described also prove that the fungus can pass through the entire cycle of its development as a saprophyte."

Three years later Went of Java published a paper entitled "Notes on Sugar Cane Diseases" in which he criticized the work of Massee. He says,—

"In most cases this disease only attacks cuttings, though it may be found in the stems of half-grown or full-grown cane too, if these are damaged; but this last mode of occurrence of the disease is rare."

* * * * * * *

"The paper by Massee on *Trichosphaeria sacchari* gave me the impression that what he calls the macro- and micro-conidia of this fungus are similar to or very little different from the form which I have described as *Thielaviopsis athaceticus*. This opinion was confirmed by the material I received from the West Indies containing so-called macro- and micro-conidia of *Trichosphaeria*, which could not be distinguished from my *Thielaviopsis*."

* * * * * * *

"*Thielaviopsis ethaceticus* is a general saprophyte, behaving sometimes as a wound parasite, and then causing the pineapple disease of the sugar cane in Java."

Butler (1906) of India wrote as follows,—

"One of the most serious cane diseases of Java is that caused by this fungus. It Attacks chiefly planted-out sets, which are rotted by its action and consequently fail to germinate. Cut or bruised canes that are exposed to its attacks are readily infected, and hence the danger to which canes reserved for seed are exposed, while they are stored or in transit, is considerable. Through the unbroken rind of the culm infection appears rarely to occur."

Johnson and Stevenson (1917) of Puerto Rico say that,—

"The injury caused by this fungus is restricted to the cane cuttings. An affected cutting is usually killed either before any shoots are produced or before the new shoots can establish themselves on their own roots. The loss due to this disease varies considerably, depending upon the variety of cane, moisture conditions in the soil, and possibly other factors. . . Not all seed which fail to germinate have been invaded by this fungus, but it is responsible for the death of a large proportion. Out of one lot of dead seed examined, twenty-five per

cent showed this disease and another lot but ten per cent. The loss in some instances, however, must be much higher. Of healthy seed growing under normal conditions a negligible per cent will be attacked. The disease makes great headway whenever conditions for prompt germination are lacking, and become especially severe if the seed has been left in piles or sacks for some time after cutting. For this reason all seed that is to be shipped or which it is not possible to plant at once should be treated.''

Edgerton and Moreland (1920) of Louisiana published a bulletin on effect of fungi on the germination of sugar cane in which they said,—

''*Thielaviopsis paradoxa* occurs very sparingly in Louisiana and as yet does not seem to be responsible for much deterioration.''

Lee (1922) of Hawaii writing of *T. paradoxa* in Philippine Islands says,—

''One of the most serious diseases of sugar cane is the so-called pine-apple disease. The affection is found most commonly in the cuttings, and frequently results in the failure of 50 to 75 per cent of the seeds to germinate. Not infrequently a complete failure results. Plants that do grow from diseased cuttings are generally diseased. In the early stages of infection, diseased cuttings, when split open, are seen to be characterized by a reddening of the tissues, usually in blotches. In advanced cases the red discolored areas turn black with reddish margins and a pineapple odor is given off. Such cases may also have a black mold produced in advanced portions of the infection. Frequently a reddening of the stalk is produced on the cane seed.''

Lee (1922) of Hawaii writing of *T. paradoxa* in Philippine Islands says,—

''Many fields have been observed which had to be entirely replanted or which were entirely abandoned due to lack of germination of the seed caused by this disease. Such loss is in most cases entirely unnecessary.''

Cottrell-Dormer (1925) of Australia wrote,—

''It has been responsible for rather serious damage over an area of one or two acres of heavy black soil. This disease is a very well known one in other countries, and has already been recorded for Queensland. It is a disease of the set and is caused by a fungus which infects tissues of the plant and prevents it from germinating.''

The disease in Puerto Rico attracted the attention of the writer first during the winter of 1927–28 when he received many complaints concerning poor germination. An investigation showed that *Thielaviopsis paradoxa* was the cause of this poor germination and that it was most severe in cold, wet clay soils. No severe outbreaks have been reported since that time. The disease and the fungus causing it have been the subjects of study ever since that date.

Inquiry concernings poor germination in previous years showed that in the opinion of the growers the poor germination was due to poor seed cuttings. The writer is inclined to believe that poor germination in most cases has been due to this fungus combined with unfavorable soil and weather conditions. It is the common practice of the Puerto Rico growers to use seed cuttings with three buds and tests have shown that three bud cuttings are more satisfactory than two or one bud cuttings. This appears to be due to the rapid destruction of short cuttings by this fungi before the young plants can become well established. The dipping of cuttings in Bordeaux mixture which has been practiced to some extent here and in other places has no doubt been advantageous when the cuttings were dipped before they became infected. When the cut surfaces of short seed pieces which are used for experimental purposes are dipped in melted paraffine or tar, the germination was almost or entirely perfect.

The fungus grows readily as a saprophyte, as stated by previous workers. It penetrates wounds of healthy cane and destroys the cell walls of the parenchyma tissue. The first symptoms of the disease is a reddening of the tissues, followed by blackening and a complete breaking down of the parenchyma. In most cases, pure cultures can be obtained from the inner-blackened tissues of these cuttings, showing that the fungus alone is capable of destroying the tissues. Other organisms, especially bacteria, can be obtained near the cut surfaces. The fibro-vascular bundles withstand destruction for a very long time. When the rind is cut through and the cane broken, these bundles can be pulled out in mass like the hairs of a brush.

Field planting at intervals of six or eight weeks have been made over a period of about two years, using both infected and uninfected seed cuttings. Each seed piece had three buds which is in accordance with the planting practice in Porto Rico and were of about the same age. Fifty cuttings of each variety were used in each test. After six or eight weeks the cuttings were lifted, examined and of the number of buds germinating on each piece recorded. These studies show:

(1) *Thielaviopsis paradoxa* is the dominant factor in poor germination in Porto Rico. It lives as a saprophyte on the old canes and is an active wound parasite.

(2) It is most severe during the cooler months of the year. In fact it is rather difficult to get cultures from the lowlands during the summer months and cultures in the laboratory die out. The organism is abundant and vigorous in the higher elevations where the temperature is lower during the summer months.

(3) The destruction of seed cuttings is greatest in the wet, poorly drained soils.

(4) Short seed pieces are usually destroyed more rapidly than long seed pieces of corresponding ages.

(5) The loss of short seed pieces in experimental work and in the propagation of a new variety is sometimes very high. This can be prevented by dipping the freshly cut ends in Bordeaux mixture, paraffine or tar.

(6) The losses from year to year are not equally severe. Sometimes the losses are very high and sometimes very low, depending on local condition, but always higher than the grower believes them to be.

(7) Other fungi and bacteria are more or less common on the decaying cane, but I have no doubt that *Thielaviopsis paradoxa* is the dominant factor in Porto Rico.

(8) *Masamius sacchari* is sometimes quite common; the mycelium forming a net work on the seed pieces and killing some of the buds, but I am unable to say just how important it is.

(9) The fact that *T. paradoxa,* which thrives best during the periods of low temperatures in Porto Rico, is not more destructive in the extreme northern and southern ranges of sugar production, would make temperature studies on the organism in different parts of the world very desirable.

(10) It is very evident that any organism that rots the seed pieces or kills the young buds will reduce the percentage of germination. Also, it is evident that the cut ends of seed pieces are ideal for the penetration of semi-parasitic and rot organisms.

(11) My studies in Porto Rico indicate that *Thielaviopsis paradoxa* is the most important organism in reducing germination. That it is most severe in poorly drained soils and during the cool months of the year. *Marasmius sacchari* attacks and kills buds and young shoots and is probably second in importance.

(12) Comparative studies on causes of poor germination in different parts of the world might gives us some interesting results.

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MARASMIUS SACCHARI; A PARASITE ON SUGAR CANE

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Marasmius sacchari was discovered in Java and described in 1895 by Wakker who believed it to be a parasite on sugar cane and the cause of a disease of the roots. His ideas have been very generally accepted from that time to the present, but some few workers have questioned the parasitism of the organism and its importance as a pathogene. These differences of opinion led the writer to conduct the studies which are recorded in this paper.

The Java growers and their scientific advisers did not believe that this fungus was the lone cause of the troubles they were having at that time and employed Dr. Z. Kamerling to devote all his time to the problem. His studies from 1900 to 1903 resulted in several papers and a book on root diseases of sugar cane. He suggested soil conditions, poor aeration and mechanical injuries are the true causes but his evidence has not been considered as conclusive by the students of the subject.

The second report of the disease was from the West Indies where it was studied by Howard of the Imperial Department of Agriculture from 1899 to 1902. He accepted the work of Wakker but he did not demonstrate the pathogenicity of the fungus. He said,—

> "The common root disease of the sugar cane in Barbados is caused by the fungus *Marasmius sacchari* Wakker, the mycelium of which is able, under certain conditions, to overcome the growing point tissues of the developing roots of the cane."

He described the symptoms as follows,—

> "Black elliptical areas, surrounded by a reddish border, are also abundant on the leaf-sheaths, which are in some cases slimy to the feel on the inside after a rain, when hard, yellowish, spherical bodies, about the size of a small pea, attached to the outside of the leaf-sheaths by whitish threads are to be seen."

In his discussion he states the sporophores follow the rains and that they dry up quickly; that the mycelium is septate with clamp connections; that the root cap and cortex are invaded by the mycelium and the tissues killed; that the periblem and pleurone are invaded and the growing point destroyed; that the undeveloped roots are marked by brown spots; that new shoots may be killed; that

the vascular bundles may show gumming; and that the pea-like bodies are sclerotia.

He also states that the spore germinate in cane extract in 90 minutes and form stellate colonies; that crystals form at the growing ends of the mycelium in about seven days; that some of the filaments become gelatinous in about 12 days, which probably accounts for the cementing of the sheaths; that rhizomorphs are formed on the sides of the glass containers; that it becomes dormant very readily: and that he demonstrated that the sporophores were developed from the mycelium.

In his discussion of the symptoms, he said that the diseased canes were dwarfed and tended to throw up young shoots; that the dead leaves adhered to the stalk and were cemented together by a white, musty smelling, fungoid growth. The canes could be pulled easily, owing to the destruction of the roots and were very light. The roots do not develop or stop growing very early. The lower leaf bases are difficult to remove. The vascular bundles are reddish in color. As the canes mature, cavities are formed in the internodes and become filled with the mycelium of the fungus.

Cook and Horne (1907) reported a root disease from Cuba which was apparently due to *Marasmius*. The following year, Horne reported *M. sacchari*.

Lewton-Brain (1905) reported a *Marasmius* from Hawaii which he believed to be the same as *M. sacchari* of the West Indies. The following year, Cobb classified this fungus as a variety under the name of *Hawaiiensis*.

In 1909 Cobb wrote as follows:

"Since that bulletin was published other specimens of Marasmius have been found on the island of Oahu that correspond more nearly with the Javanese species, and leave no doubt that we have in Hawaii the same fungus that causes the root-disease of Java and the West Indies, as reported by various observers. It seems possible that the variety Hawaiiensis may have to be raised to the rank of a species, as the differences are even more marked than I had thought from a reading of the descriptions of the species sacchari."

"In the variety Hawaiiensis the young fructificactions were white, while in certain specimens, found later, they are broken. While the upper surface of the pileus in variety Hawaiiensis is smooth, in the specimens here referred to it is radially fibrous, the color being light brown and the fibres hardly projecting sufficiently to produce an actual hairiness."

"These specimens of the true *M. sacchari* are quite as large as the specimens of the variety Hawaiienses described in Bulletin No. 5, and therefore exceed the dimensions given in the original descriptions of the Javanese species."

"They accord more nearly with the size of the specimens of *M. sacchari* found in the West Indies."

In 1908 Fulton reported *Marasmius plicatus* Wakker as being the cause of heavy losses in Louisiana. Some years later Rinking reported this species growing on rotted stems in the Philippine Islands.

Edgerton (1910) writing of the root rot caused by *Marasmius plicatus* says:

"This disease attacks both the cuttings and the growing cane. On the growing cane, it kills the roots and grows in between the lower leaf sheaths. The leaf sheaths are not shed as is the case with healthy cane, but remain glued together around the stalk. If some of these are pulled apart, a network of white mycelium will be seen between them."

"On the cane which is used for seed, this disease will also develop. I have seen it to some extent in nearly every batch of cane which has been sent me this year. The mycelium enters the cut ends of the stalk and grows through them. The disease is readily told by the presence of the white strands of mycelium which may be on or in the stalk. Sometimes the eye is killed before germinating, and sometimes the young plant is killed after germination."

Johnson and Stevenson (1917) published a paper on sugar cane fungi and diseases in Puerto Rico in which they record *Marasmius sacchari* Wakker, *Himantia stellifera* Johnston, *Odontia saccharicola* Burt and *O. sacchari* Burt growing at the base of cane stalks and apparently attacking the roots.

They say:

"The exact status of root diseases with respect to the parasitism of *Marasmius, Himantia, Odontia* and possibly other forms is uncertain, and while it is generally held that *Marasmius* at least is a true parasite, really definite evidence is lacking. Studies under control conditions must be carried out working with pure cultures of the fungi which has not yet been possible."

In their discussion of *Marasmius sacchari*, they said,—

"The injury caused is primarily upon the roots. The mycelium enters the roots, disintegrates the tissues and prevents a proper absorption of water and nutriment from the soil. As a result of this injury to the roots there is the secondary effect upon the development of the plant. According as the attack is severe or mild, the host shows a varying amount of leaf curling, a dwarfing of the stool, and often an early succumbing to less vigorous parasites such as *Melanconium*.

"Injury to the roots can be ascertained by direct examination, a slow tedious process, or to a certain extent can be diagnosed by symptoms above ground. The fungus itself eventually appears on the cane above ground, growing within and upon the lower leaf-sheaths, sometimes one-half or two-thirds the height of the stalk. The external appearance is a white mycelial growth, which is conspicuous by its rather smooth membranous appearance in contrast to a distinct filamentous growth. Tearing away the affected leaf-sheaths reveals the fact that they are decayed, and are glued together as it were by the membranous growth, to the underlying sheaths and the stalk. The decay of the lower sheaths may or may not in itself be of great importance, but the binding of the leaf-sheath to

the stem is very undesirable from the view point of the mill worker who prefers clean cane.''

''This fungus, like some others, appears to make great headway when once it has attained a strong foothold on the host. Thus the fungus may develop well on plant cane without doing appreciable injury, but may increase its foothold on the ratoons so as to do double the injury. As a result of this action it is a common sequence that plant crops are fair in certain localities, the first ratoon is considerably poorer, and the second ratoon often dies out completely. The damage may be restricted to one or a few stalks on a stool, or more commonly it may affect an entire as well as one or more adjacent stools to form the characteristic spots, or more rarely large portions of the field are entirely affected.''

''The injury to the plant may be considered threefold: the growth of the plant is checked often to the point where no merchantable cane is produced, the matter of clean cane is rendered difficult, and the cane becomes more susceptible to other diseases.''

The geographical distribution of *M. sacchari* and related species may be summarized as follows,—*M. sacchari* has been reported from Java, India, Australia, Formosa, Hawaii, Porto Rico, Jamaica, Lesser Antilles, British Guiana and South Africa. *M. plicatus* from Java, Philippines and United States; *M. stenophyllus* from Santo Domingo and Lesser Antilles; *Marasmius* sp. from Fiji, Central America and Brazil; and *Hypochnus sacchari* from Cuba and Jamaica.

Matz, Earle and some others did not believe that *M. sacchari* was an important parasite. In 1920 Earle said:

''*Marasmius* is at best a very feeble parasite. It may over-run new healthy roots or other organs without killing them.''

After a discussion of *Rhizoctonia* and *Pythium* he says:

''Nothing could be more convincing than that these heretofore unsuspected species and not *Marasmius* and its allies are the true root-killing agents.''

Matz (1920) said:

''It was noticed that in the *Marasmius* pots, although the white threads of the fungus had penetrated through the upper three or four inches of soil, the growing roots of the cane seed were not affected in any unusual way. Mycelium was observed on some roots but no rotting took place. However, after three months from inoculation there could not be seen any appreciable difference in the growth between any of the inoculated plants and those used as checks.'' * * * ''Four months from inoculation the pots inoculated with *Marasmius* produced the fruiting stage of the fungus at the same time the cane plants were among the tallest and most vigorous ones.''

When the inoculated plants were removed from the soil, Matz states that—

''in the case of *Marasmius*, although the fungus mycelium was plainly visible in amongst the soil particles, yet the roots did not show as much decay as in

the first two (i. e. *Rhizoctonia* and *Pythium*). * * * The roots of the check plants were normal.''

In speaking of another experiment he says:

''Although the fungus mycelium of *Marasmius* was in contact with the roots there were no signs of decay in them.''

Van der Bijl (1921) of South Africa says:

''A soil fungus common in cane fields is *Himantia stellifera,* 'the stellate crystal fungus'. This fungus is evident at the base of the cane, cementing the basal leaves together, and when the cane stool is opened interwoven white threads of the fungus are also seen in the ground between the cane roots.''

''In smothering the young buds the fungus lessens the stand in ratoon crops, and it has also been observed to prevent the growth of planted cuttings.''

''It is responsible for killing the rootlets, of the cane, and it thus weakens the plants and makes them more liable to attacks by other fungi; and with a diminished root system the plants are in periods of drought not in the best position to obtain from the soil the water it still contains. Plants having their roots attacked by this fungus invariably suffer more from the effects of drought.''

''Under the microscope this fungus is easily distinguished from all others by the stellate crystals which are borne on branches of the vegetative threads of the fungus. These crystals have given the fungus the popular name of 'Stellate Crystal Fungus'.''

''In addition to cane, the fungus has been observed on the 'umthente' grass *(Imperata arundinacea)*, and it probably occurs and vegetates on other grasses as well.''

''On cane the fungus is of the nature of a weak parasite and control methods should aim at thorough cultivation to ensure a vigorous growth of cane, conservation of soil moisture, and aeration of the root system.''

In 1921 there was a severe outbreak of root rot on EK 28 in Java, which was studied by Dr. J. Kuyper. In his opinion this disease was not due to a parasite but to soil conditions and to stagnant water in the soil.

Matz (1921) of Porto Rico described and discussed the relationship of several species of *Rhizoctonia* to root rots and Bourne of Barbados gave proof of the pathogenicity of *R. solani* and *R. palida.* Bourne said:

''The writer has confirmed the observations made by Matz relative to the absence of the fungus *Marasmius sacchari,* Wakker, binding the basal leaf sheaths to the stalk in otherwise typical cases of root disease. Indeed, in some instances other common saprophytic fungi, e. g., *Trichoderma lignonum* were present to the exclusion of *Marasmius.* Thus it is evident that in Barbados as in Porto Rico the presence of either one or both of these latter fungi commonly associated with decaying leaf sheaths and cane bases is of no significance whatever and may or may not be associated with typical cases of root disease, depending on whether they happen to form part of the fungus flora of the soil giving rise to root diseased plants. Some plants are so seriously attacked that they are only about

one-half the size of those in their immediate vicinity which apparently have not yet contracted the disease but which did so a few weeks afterwards. The yellowish unhealthy appearance of the leaves of these attacked stools was very significant when a comparison was made with those plants which were not yet suffering from the disease although growing in the same field quite close to the former."

"*Marasmius sacchari* has never been isolated from freshly diseased and dying cane roots but only from dead ones."

Nowell in his Diseases of Crop Plants in the Lesser Antiller (published about 1922 or 1923) says:

"Instances have on several distinct occasions come under the observation of the writer in young plant canes in Barbados, and recently in fields of first ratoons in Trinidad, in which plants growing in good well-tilled soil and previously healthy and vigorous have rapidly failed, and have been found to be heavily infested with *Marasmius*, not only on the roots and leaf-sheaths, but in the tissues of the basal joints of the cane. In such cases the fructificactions of the fungus have been produced with unusual readiness and in considerable quantity."

"The attacks on plant canes have occurred in somewhat scattered stools during the dry season. On one occasion numbers of stools Ba. 6032 were quite killed out in this way, while plants of B–6450, in the same field, which were not nearly so forward, were unaffected. The basal joints, and the sprouting buds in all stages were internally reddened and filled with *Marasmius* mycelium. This type of disease agrees with the effects of *Marasmius sacchari* as first described by Wakker in Java, where the ordinary West Indian type, presumably owing to the scarcity of ratoons, does not seem to be familiar. In Barbados *M. sacchari* was the species met with in the cases described."

"The most striking instance seen in Trinidad was in a field of Hill's Seedlings 6 to 12, unusually well-grown first ratoons in deep and fairly heavy loam, sufficiently drained. Very many of the large canes were badly infested or completely rotted for several joints at the base, the parts above remaining sound until dried up by the cutting off of their supply of water. The young leafy shoots were also dying upwards owing to infestation in their base. The stools were exceedingly loose in the soil, and many were turned out by the weight of their own canes. An unidentified species of *Marasmius*, with bluish black stalks, was fruiting abundantly from the roots, the root 'eyes' on the stem, and the young shoots. Other fungi were not conspicuous."

"While no proof can be offered, the cases described, and others similar, present the appearance of active parasitism by *Marasmius* species. The Barbados examples were attributed to the weakening of resistance by drought, and stools not completely killed recovered after rain. The sudden failure of the Trinidad field described could only be attributed to the effect of a second dressing of sulphate of ammonia on a soil already almost depleted of its small supply of lime."

Lyon (1923) of Hawaii published a paper in which he said,—

"An intensive study of root-rot in the field and laboratory conducted by Larsen and Lyon served to demonstrate that *Ithyphallus* * and *Marasmius* had no

* This fungus was reported as the cause of a root-rot in 1906, but further studies have failed to prove its pathogenicity.

primary connection with epidemic root-rot in Hawaii and that other fungi were responsible for the destruction of the cane roots. These fungi were taken up in turn but each failed to qualify under test as the primary cause of root-rot. Finally by transferring diseased cane stools from diseased to healthy fields, it was demonstrated that these fungi could not materially check the growth of the cane plant if the soil conditions were right. Evidence deduced from extensive field studies and many experiments performed seem to prove that the cause of root-rot in Hawaii was some non-parasitic factor resident in the soil and to indicate that this factor was in the nature of a poison.''

''It is a fact recognized by all pathologists that the ultimate destruction of the tissues of the root system is brought about through the action of organisms dwelling in the soil. This is, of course, the fate of all roots that die from any cause whatsoever, so the decay of roots induced by organisms does not, by any means, prove that the death of the roots was due to these organisms. Among the organisms found in cane roots in areas where root-rot is prevalent are several forms with pronounced parasitic abilities. They are capable of attacking, and do attack, live cane roots, bringing about the destruction of the latter. The only question is: can they, unaided, destroy the roots rapidly enough to produce root-rot in cane? Some pathologists say that they can, while others say that they cannot unless the vitality and resistance of the cane is first reduced or broken down by some non-parasitic factor in the soil. We are, therefore, confronted with two opinions regarding the primary cause of root-rot and we may profitably consider each in turn as correct and see what course should be followed under the circumstances.''

Earle in 1927 referred to the work of Matz on *Rhizoctocnia* and *Pythium* and said:

''He also showed that pure cultures of *Marasmius* had not such effect, but that the cane roots continued sound even when envolved in masses of conspicuous white mycelium. * * * No evidence has been adduced to show that either *Marasmius* or the other hymenomycetes found on cane roots are ever parasites. They may interfere somewhat with normal growth but they do not kill roots.''

He also said,—

''A considerable number of contributory causes of root disease have already been indicated. Doubtless the list could be extended, but the fact would remain that the great majority of cases are caused by a bad physical condition of the soil, resulting in lack of aeration for the roots. Like all living things, the cane roots must have oxygen in order to function properly. If the soil is unduly compacted or heavily crusted the supply is interfered with. If the soil becomes waterlogged for even a few days, trouble is almost certain, for cane is not an aquatic plant and its roots cannot take their oxygen supply from water. Probably lack of drainage is responsible for more cases of root disease than all other factors combined. Standing water for even a few days is almost certain to weaken the roots. The effects will probably not be observed until the first sharp drouths, when the rolling of the leaves and other symptoms of root disease will appear in all those spots where there has been standing water. Obviously such cases could be avoided by proper drainage, especially if accompanied by prompt tillage as soon as possible after heavy rains to break up surface crusting and to so open up the compacted soil as to permit air to enter freely.''

Faris and Allison (1927) said,—

"The field studies show root disease to be associated with lack of aeration in undrained soils, with high salt content of the soil, with drouth and resultant cracking of the soil, with high cutting and surface application of fertilizers, with infertile soils, and with the attacks on the roots of several * * * insects and other small animals."

In 1929 Bell published A Key for the Field Identification of Sugar Cane in which he gives the following discussion:

"Root-rots of the *Marasmius* type are those caused by weak parasites which are only capable of entering and parasitising the roots after the latter have been weakened by unfavorable soil conditions or damaged by the small animal life inhabiting the soil. These rots are characterized by the fact that they affect the cortex only, and the fungi are apparently unable to penetrate the endodermis and destroy the stele or conducting tissue. The roots consequently retain their rigidity and do not become flaccid as happens in the pythium type of rot, where the stele is destroyed. A fungous rotting of the cortex of the older portions of the roots is accepted as a normal process and probably does little or no harm. When the plant is weakened these fungi are enabled to enter the cortex of the young roots, causing a brownish-red, and destroying the growing tips of the primary and secondary roots. Abnormal branching of the roots follows and the tips of these branches are in turn killed, and as a result of the greatly reduced root system diseased stools are often very easily uprooted from the soil. Such fungi are often associated with a cementing of the lower leaf sheaths, a common occurrence in the rot caused by *Marasmius sacchari*, when the leaf sheaths are bound together by a white mycelium. In the later stages of the rot caused by *Marasmius sacchari* it is often possible to find the small mush-room-like fruiting bodies at the base of the diseased stools."

Carpenter (1932) of Hawaii presented a paper to the International Society of Sugar Cane Technologists in which he said,—

"Growth failure of cane in Hawaii embraces a division of the diseases coming within the category of root disturbances into two main forms: (1) Miscellaneous failures fundamentally nutritional in nature, caused by faulty soil conditions in restricted areas, (2) root disease caused by *Pythium aphanidermatum* accelerated by excessive amounts of nitrogenous nutrients for the particular variety."

* * * * * * *

"Emphasis in our growth-failure investigations has gradually shifted from studies of the parasitic root diseases which have now been clarified, to consideration of the soil conditions at fault in the localized areas where cane does not grow normally. The great majority of persistent growth-failure areas appear to be naturally poor soils where cane has never grown well."

During the past few years the writer's attention was called very frequently to plants which were making poor growth: The lower leaves were dead and bound together and to the base of the plant with a weft of white mycelium which extended both above and below ground. Young canes were sometimes killed but it was impossible to

say that they had been killed by this fungus. The roots were very generally in bad condition but it was impossible to say that it was due to the fungus. The symptoms, character of the fungus and the presence of occasional sporophores indicated that we were dealing with *Marasmius sacchari* but it was evident that no definite statement could be made from field observations only.

Laboratory studies proved that the fungus could be isolated very easily and that it grew well in culture, especially on pieces of cane that had been sterilized in the autoclave, but some difficulty was experienced in growing it on living cane. This was overcome by growing sterilized cuttings in glass cylinders and inoculating with the fungus grown on sterilized cane plugs as follows:

(1) A small amount of water was put in the bottoms of glass cylinders which were about 15 inches in height and sterilized in the autoclave. (2) Pieces of cane about two inches in length and bearing one bud were sterilized in 1 to 1000 corrosive sublimate solution, dipped in sterilized water and then dropped into these tubes. (3) The fungus was isolated and grown first on agar and then on plugs of sterilized cane in test or culture tubes. (4) A reasonable time was allowed to make sure that the cuttings were sterile and that the fungus was making a good growth on the plugs. (5) The inoculated plugs were then dropped into the tall tubes at intervals so that young plants of various ages might become infected. Sometimes the plug was placed in contact with the cuttings and at other times in contact with the young shoot.

The fungus grew rapidly, spreading over the surface of all parts of the cutting except the part which was submerged in the water. It also covered the roots above the water but not those that were below the surface. It attacked any part of the young shoot with which it cane in contact, gradually penetrating and completely covering the smaller ones. Buds that were covered early never germinated. Young shoots were killed more quickly than the older shoots.

Young cane plants were grown in sterilized soil and inoculated by pushing infected cane plugs down into the soil beside them. The growth of these plants was dwarfed but none of them killed.

Large plants grown in unsterilized soil in the green house were cut and infected plugs were pushed into the soil beside them. Some of these plants did not grow well but it was impossible to say definitely that the fungus was the cause of the poor growth.

HISTOLOGY

When small amounts of agar containing mycelium were placed in contact with the young canes growing in glass cylinders, the results were negative in most cases, probably because of the rapid drying of the agar. When plugs of sugar cane, which had been inoculated with the fungus were placed in contact with young canes growing under the same conditions, the mycelium spread over the surface of the cane very rapidly and caused a darkening and a killing of the tissues and eventually a killing of the plant. Micro-preparations were made from these infected plants and the story is told in figures 1 to 5. The fungus formed a mass of mycelium over the surface and between the leaves (Fig. 3). It penetrates the cells of these young plants very readily and could be found in all cells except those with very thick, hard walls such as are found in the fibro-vascular bundles. In case the inoculated plugs are brought into contact with the tip of the young cane the mycelium may penetrate the young part of the fibro-vascular bundles.

Sections were made of infected roots and the fungus found in all parts, although less abundant in the cells of the fibro-vascular bundles (Fig. 1).

DISCUSSION

The studies recorded in this paper indicate that *Marasmius sacchari* is a very common and widely distributed saprophyte which grows abundantly on dead fragments of cane and that under favorable conditions it may become an important parasite.

It attacks leaves, stems and roots and there is no more reason for calling it a root parasite than for calling it a leaf or stem parasite. It attacks young canes and kills considerable numbers of them. I am unable to say just how important it is or just what conditions are most favorable for its growth. When the growth of the cane is retarded it may come in as a secondary factor and do much damage to the crop. It is a common parasite on old and dying cane.

It attack seed cuttings, covering them with a weft of mycelium, killing the buds and causing them to rot, but the decay is not so rapid as that cause by *Thielaviopsis paradoxa*.

The symptoms are quite definite but some of them may be due to other causes. The binding of the leaves at the base of the cane is one of the most distinctive characters on growing cane. Young canes may be killed and completely covered with mycelium. Seed pieces may be completely covered with mycelium and the buds killed. The presence of the fungus on cane does not necessarily indicate that it

is the cause of retarded growth or the death of the cane. The cane may be weak or have died from other causes and *M. sacchari* may be secondary. The writer has never found sporophores or any other than dead canes.

The parasitism of the fungus cannot be doubted. The writer has demonstrated that the mycelium will penetrate the tissues readily and kill growing cane.

The environmental factors are very important and there is much truth in statement of Kuyper, Earle, Lyon and Carpenter concerning soil and water but none of these workers have demonstrated that the fungus is not a parasite. The fungus can nearly always be found on cane that has made a poor growth as a result of soil and water conditions that are unfavorable for the growth of the cane and it can be found also on cane that has been injured or retarded by other fungi.

The writer has found many dead shoots in fields which were evidently killed by this fungus although most of the cane was making an excellent growth. Poor drainage is an extremely important factor, especially in the killing of the buds on seed pieces.

In general it is of minor importance but the losses are sometimes greater than are attributed to it by most growers. Good soil, proper use of fertilizer, good preparation before planting, good drainage and good cultivation are most important factors in the control of this fungus.

SUMMARY

1. The fungus is a vigorous saprophyte, which can be found in abundance on fragments of cane and cane leaves in and on the surface of the soil. Also on the old dead leaves of growing canes.

2. The mycelium frequently cements the leaves and checks the growth of the canes, but its presence does not necessarily indicate that it is the cause of the retarded growth or the death of the cane.

3. The fungus is a parasite and penetrates roots, leaves and stalks of young canes very readily.

4. It kills a small percentage of young canes and sometimes injures older canes. These losses depend on soil and climatic conditions and vary with the seasons. They are probably less than some reports indicate and greater than is indicated by others.

5. The fungus sometimes attacks seed cuttings and kills the buds. The writer has one record of a killing of 20 per cent.

6. The writer has not observed the pea-like bodies which Howard described as sclerotia but has observed the large sclerotia formed by

Rhizoctocnia grisea which was described several years earlier as *Sclerotium griseum* Stevenson.

7. The writer has demonstrated that the fungus will grow from old material or from a pure culture and penetrate the living tissues of canes growing in glass cylinders or in sterilized soil in pots.

8. The fungus penetrates the canes, leaves and roots and will kill many of them when the conditions are favorable.

9. A considerable amount of the fungus either in or outside the cane appears to be necessary for the production of sporophores.

10. Sporophores were produced in my cultures, on cane grown in cylinders, in from two to four months after inoculation.

Explanation of Plates

PLATE XIX

A young shoot killed by *Marasmius sacchari* in the field.

PLATE XX

Two shoots grown in glass cylinders. The one on the right shows the first mature sporophore grown by this method.

PLATE XXI

right shows the first mature sporophore grown by this method.

Left; cane grown in ordinary field soil.

Right; cane grown in soil of the same kind that had been sterilized and then inoculated with *Marasmius sacchari* by pushing infected pieces of cane in the soil.

PLATE XXII

Seed cutting covered with *Marasmius sacchari*. One bud killed. Two shoots heavily infected with the fungus.

PLATE XXIII

Figure 1. Cross section of root from surface to center showing mycelium in the cells; also (*a*) mycelium on surface, c marks the center of the root.

Figure 2. Cross section of young leaf showing mycelium in the cells, a, upper epidermis.

Figure 3. Cross section of older leaf showing mycelium in cells and on surface a.

Figure 4. Large parenchyma cells containing mycelium.

Figure 5. Parenchyma cells next to fibro-vascular bundles, showing mycelium in cells.

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PLATE XX

PLATE XXI

PLATE XXII

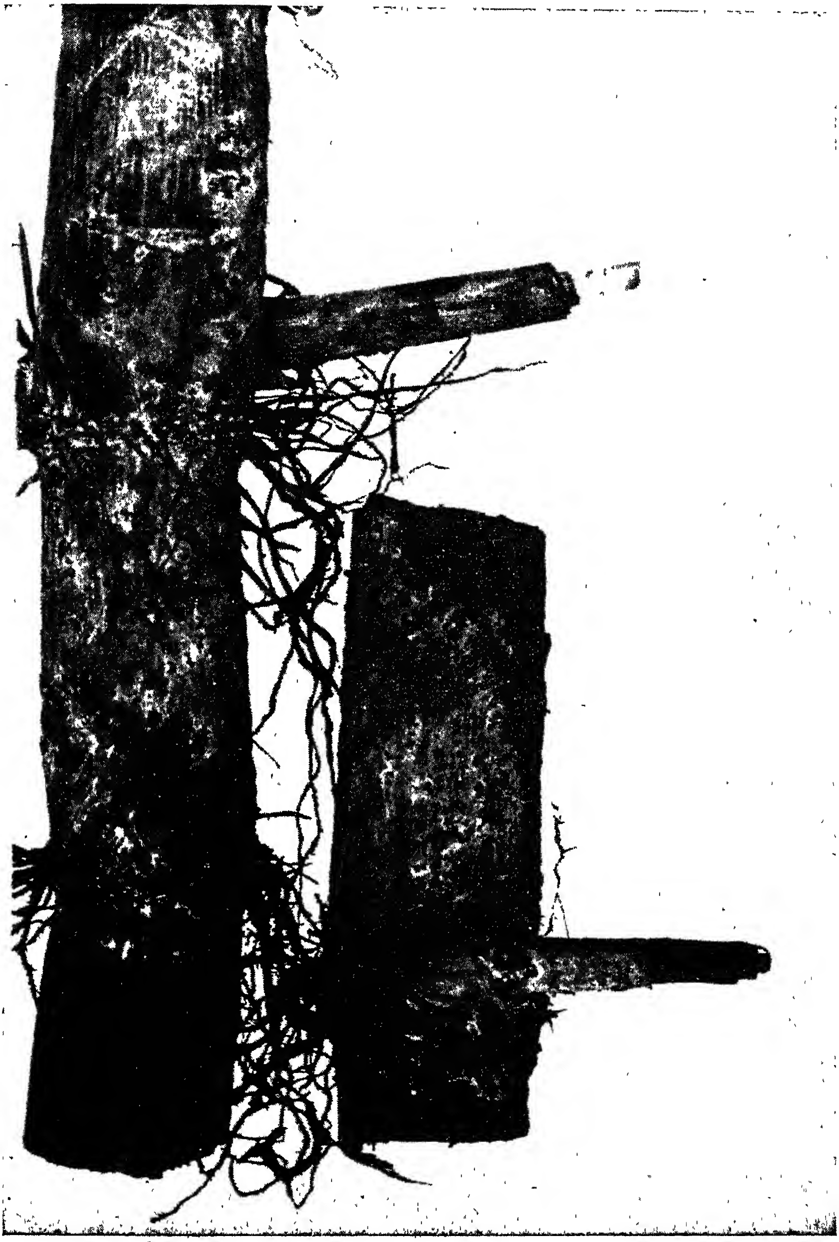
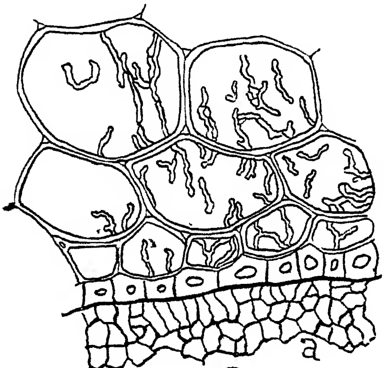


PLATE XXIII

4



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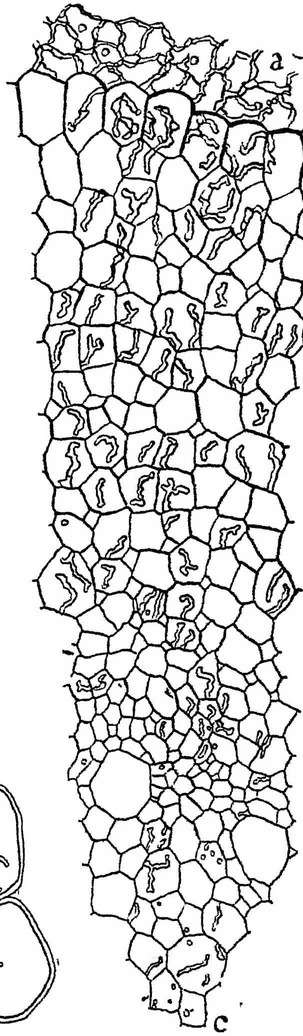

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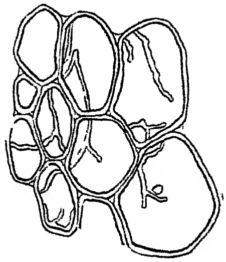

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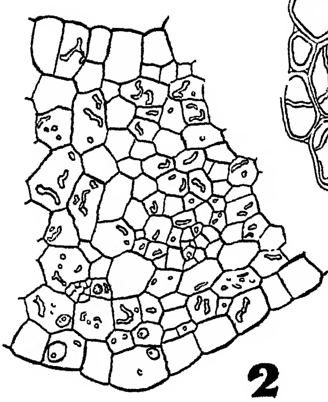

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THE CYDNIDAE AND PENTATOMIDAE OF CUBA *

By H. G. BARBER, U. S. Bureau of Entomology and S. C. BRUNER,
Cuban Agricultural Experiment Station.

The present paper is based largely on specimens in the collections of the Cuban Agricultural Experiment Station at Santiago de las Vegas and of the junior author, together with specimens in the Dr. Juan Gundlach collection which is housed in the Instituto de Segunda Enseñanza de la Habana. A close examination of the specimens in the latter has not been possible as they are preserved in sealed, glass-topped boxes from which they can not be removed for study. The species in the collection of Gundlach were named in 1883 by Professor Philip R. Uhler according to a note in the preface of his catalogue which was never published. This catalogue includes the names and synonymy of the species where known, the localities where collected, and the numbers assigned to each species both in his collection and in that of his contemporary, the Cuban naturalist Don Felipe Poey. In 1910 Dr. Pedro Valdés Ragués published a list of species in the Gundlach collection under the title "Clasificación Gundlach de Hemípteros Cubanos, Conforme a los ejemplares que Existen en el Museo del Instituto de 2a. Enseñanza de la Habana" (Anales de la Academia de Ciencias Médicas, Físicas y Naturales de la Habana, XLVI, 425–446). As noted in a copy of this list referred to later, many of the names are misspelled, so much so that some of them are scarcely recognizable. In addition to the collections of Cuban Pentatomidae mentioned above we have been able to add other species and much additional data from material in the U. S. National Museum, the Museum of Comparative Zoology, and the American Museum of Natural History. We have also frequently referred to the important article by Mr. F. E. Guérin-Méneville published in 1857 in Ramón de la Sagra Histoire Physique, Politique et Naturelle

* *Editor's Note:* The paper here published includes a number of species widely distributed in the West Indies and known also to occur in Puerto Rico. The economic importance of these stink-bugs makes the accurate diagnoses and the keys for determination of the species included of great value to all West Indian workers. This study furnishes an important comparison to a comprehensive paper now in preparation by Mr. Barber on the Heteroptera for the Scientific Survey of Puerto Rico and the Virgin Islands which includes the two families here treated.

de l'Isle de Cuba, Animaux Articulés a Pieds Articulés 359–377, in which a number of new species are described. Appended to our treatise we have arranged in parallel columns the two lists of Cuban Pentatomidae as given by Guérin and Ragués, and in the third column our determination. The illustrations were made by the senior author.

The abbreviations adopted are as follows: Est. Exp. Agron. for Estación Experimental Agronómica, Cuba; M. C. Z. for Museum of Comparative Zoölogy; U. S. N. M. for U. S. National Museum; A. M. N. H. for American Museum of Natural History.

The full names of the various collectors to whom credit is due are as follows: J. Acuña, C. H. Ballou, B. T. Barreto, P. Betancourt, L. Bouclé, S. C. Bruner, P. Cardín, C. Enamorado, W. T. Horne, J. H. Houser, J. C. Hutson, Frederick Knab, G. Link, W. M. Mann, Harold Morrison, J. G. Myers, A. Otero, S. Plá, H. K. Plank, Hermano Roberts, George Salt, L. C. Scaramuzza, E. A. Schwarz, F. Silvestri, G. F. Stahl, and G. N. Wolcott.

Types and paratypes of the new species are deposited in the U. S. National Museum and paratypes in the collection of the Cuban Agricultural Experiment Station at Santiago de las Vegas.

KEY TO CUBAN FAMILIES AND SUBFAMILIES OF PENTATOMOIDEA *

1. Tibiae distinctly spinose or spinulose, rarely setose. Only five visible dorsal segments in connexivum of abdomen (excluding genital segments). First ventral segment of abdomen, at least outwardly, entirely or almost entirely covered by the expanded margin of the metapleurum------Fam. *Cydnidae* 2
   Tibiae not distinctly spinose or spinulose, sometimes provided with setulae. Connexivum of abdomen provided with six dorsal segments (excluding genital segments). First ventral segment of the abdomen not entirely covered by the metapleurum------------------------Fam. *Pentatomidae* 3
2. Scutellum much expanded, U-shaped, nearly covering abdomen. Corium for the most part membranous and concealed; frena very short; exposed chitinous part narrow. Tibiae sometimes spinulose---Subfam. *Thyreocorinae*
   Scutellum of moderate size, somewhat triangular, not reaching to apex of abdomen. Clavus and corium not concealed beneath scutellum; frena long. Tibiae commonly more strongly spinose (except *Scaptocoris*)---Subfam. *Cydninae*
3. Scutellum expanded, U-shaped, nearly or quite reaching apex of abdomen. Chitinized part of corium exposed at base only or along narrow costal margin-- 4
   Scutellum of moderate size, commonly triangular, rarely U-shaped or reaching apex of abdomen; in the latter case the entire corium and clavus free. Subcostal and median veins set close together and parallel in Cuban species-- 6

* This key is intended only for differentiation of Cuban forms.

4. Fore wings very long, when expanded almost twice as long as abdomen; chitinized costal margin constricted and thinned at the middle point. Odoriferous orifice of the metapleurum minute, devoid of a canal and surrounding, dull, evaporating area. Antennae with only four segments. Tarsi with two segments.............................Subfam. *Megaridinae.*
   Fore wings not much longer than abdomen, when expanded; chitinized costal margin complete, not constricted in the middle. Odoriferous orifice distinct; canal present or absent. Tarsi three segmented............. 5
5. Median and subcostal veins of hind wings more or less distant and diverging, enclosing a wide median area; hamus often present. Scutellum nearly covering abdomen in Cuban species.............Subfam. *Scutellerinae.*
   Median and subcostal veins of hind wings set close together and nearly parallel; hamus absent. Scutellum not entirely covering abdomen in Cuban species; corium in part membranous....Subfam. *Graphosomatinae.*
6. Venter of abdomen provided with six visible spiracles on each side, first not covered by the expanded margin of the metapleurum. Rostrum short, commonly not extended to middle coxae. Mesosternum provided with a very strongly elevated carina prolonged anteriorly from a flat metasternal plate.................................Subfam. *Tessaratominae.*
   Venter of abdomen with five visible spiracles on each side, the first entirely or almost entirely covered by the expanded margin of the metapleurum.. 7
7. Bucculae nearly parallel or slightly diverging, not distinctly united posteriorly. Basal segment of rostrum commonly not free but confined in the rostral groove between the bucculae; rostrum commonly slender........ ....Subfam. *Pentatominae.*
   Bucculae converging and united posteriorly. Basal segment of rostrum enlarged and free from rostral groove, except at base; rostrum commonly thickened.......................................Subfam. *Asopinae.*

Family Cydnidae

Subfamily Thyreocorinae

KEY TO CUBAN GENERA OF THE SUBFAMILY THYREOCORINAE

1. Pronotum and scutellum (seen from the side) not forming together a uniform continuous curve. Costal margin of corium not longitudinally impressed, calloused. Head subtriangular, rather convex. Eyes more or less prominent beyond margins of head.................*Eucoria* M. and R.
   Pronotum and scutellum (seen from side) forming together a uniform continuous curve. Costal margin of corium longitudinally impressed. Eyes not prominent. Coriaceous part of fore wings not acute at apex but broadly truncate or obtusely rounded. Head more bluntly rounded anteriorly and rather flattened........................*Euryscytus* Horv.

Eucoria minuta (Uhler)

1863. Uhler, Proc. Ent. Soc. Philad. II: 155.

Santiago de las Vegas; El Faaile, Pen de Guanahacabibes (Bruner); Camagüey (Acuña); Baracoa, Ote. (Bruner and Boucló);

Sto. Tomás, Pen de Zapata (Bruner and Acuña); Nueva Gerona in Isle of Pines (Boucle)—Est. Exp. Agron. "Cuba"—U. S. N. M.

Originally described from Cuba and a fairly common species in other West Indian Islands. It is a small species, only about 2-2.5 mm. long, quite dull and closely punctate, with a bright orange costal margin.

Euryscytus incerta (Uhler)

1863. Uhler, Proc. Ent. Soc. Philad. II: 156.

Santiago de las Vegas (Cardín, Otero, and Bruner)—Est. Exp. Agron. "Cuba"—U. S. N. M.

Cuba is likewise the type locality of this species. It is a little larger than the preceding species, quite shiny and rather sparsely punctate. The exposed costal margin is ochraceous-red interrupted by a fuscous spot beyond the middle point.

Euryscytus guttiger (Stal)

1862. Stal, Stett, Ent. Zeit. XXIII: 94.

Santiago de las Vegas (Bruner); Camagüey (Acuña)—Est. Exp. Agron. San Carlos Estate, Guantánamo—A. M. N. H. Mina Carlota, Trinidad Mts. (Myers)—M. C. Z.

Described from Mexico and found occasionally in Cuba. It is nearly 4 mm. long. The head is very broad and rounded in front, about twice as wide as long, and very finely punctured; the scutellum is short and relatively narrow, leaving exposed most of the corium, which is broad and truncate at apex. A large pale yellow patch occupies the base of the corium. This is evidently the species referred to by Guérin in La Sagra, Hist. de Cuba, Ins., 364 as *Scutellera (Corimeloena) basalis* Germár.

Subfamily Cydninae

KEY TO CUBAN GENERA OF SUBFAMILY CYDNINAE

1. Anterior tibiae sickle shape and flattened; tarsus inserted before apex of tibia. Rostrum short, not surpassing anterior coxae; second segment swollen. Margins of head devoid of spines and setae, more or less crenulate. Apex of scutellum bluntly rounded. Posterior femora and tibiae short and incrassate, with the latter truncated at apices *Scaptocoris* Perty
   Anterior tibiae normal, fossorial; tarsus inserted at apex of tibia. Rostrum much surpassing anterior coxae. Posterior tibia elongate, somewhat cylindrical -- 2
2. Odoriferous orifice terminating in a long, distinctly elevated canal. Margins of head armed with comb-like teeth or spines. Two clavi of the fore wings meeting behind scutellum to form a commissure. Scutellum acute at apex -- *Amnestus* Dallas

Odoriferous orifice not terminating in a long distinct canal, set beneath an overhanging ledge. Two clavi of fore wings not meeting behind scutellum, devoid of a commissure. Scutellum not acute at apex. Anterior submargin of pronotum not transversely impressed........................ 3

3. Submargins of head deeply grooved and beset with slender, acute spines and long setae..*Aethus* Dallas.

Submargins of head neither deeply grooved nor armed with spines........ 4

4. Outer end of the short odoriferous canal flaring or expanded in the form of a concave lobe..................................*Geotomus* M. and R.

Odoriferous orifice set in a preapical notch of the overhanging ledge, not flaring or expanded exteriorly........................*Geocnethus* Horv.

Scaptocoris terginus Schioedte

1849. Schioedte, Kroy. Nat. Tidskr. II: 460.

1881. Signoret, Ann. Soc. Ent. Fr., p. 42; Pl. I, Fig. 3.

A South American species recorded by Signoret from Cuba. There is a specimen from the island of Trinidad in the National Museum collection but none from Cuba.

Aethus communis Uhler

1877. Uhler, Bull. U. S. Geol. Geogr. Surv. III: 379.

1882. Signoret, Ann. Soc. Ent. Fr. (6) II: 35, Pl. 2, Fig. 76.

Taco Taco (Bruner, Acuña, and Ballou); Santiago de las Vegas (Barreto); Havana (Bruner); Península de Guanahacabibes, Pinar del Rio (Bruner)—Est. Exp. Agron. Cayamas (Schwarz), Baraguá (Scaramuzza)—U. S. N. M.

Described by Uhler from our southern states and Cuba. It is black, about 6–7 mm. long, with the bluntly rounded head provided on each side with 10–11 short submarginal spines and several long setae. The pronotum is almost impunctate and provided with a submarginal row of 16–18 long setae; costal margin of the hemielytra furnished with about six long setae.

Aethus indentatus (Uhler)

1887. Uhler, Bull. U. S. Geol. Geogr. Surv. III: 380.

1882. Signoret, Ann. Soc. Ent. Fr. (6) II: 38, pl. 2, Fig. 80.

Santiago de las Vegas (Barreto, Acuña, and Bruner)—Est. Exp. Agron. Soledad and Mina Carlota (Myers)—M. C. Z. Cabanas, Pinar del Rio—A. M. N. H. Cayamas (Schwarz)—U. S. N. M.

Described from Cuba and southern Florida. Much smaller than the preceding species. It has a few spines on each lateral lobe of the head (5–6), five setae on the lateral margin of the pronotum, and but a single setigerous puncture on the coastal margin. The males have the anterior disk on the pronotum quite plainly depressed.

Geocnethus Horvath

1919. Horvath, Ann. Mus. Nat. Hung. XVII: 245.

Closely related to *Geotomus* in which genus Signoret placed several species which Horvath remarks belong to Geocnethus. The submargin of the head is neither deeply impressed nor armed with spines; eyes posteriorly with a single fine horizontal seta; entire lateral margin of pronotum impressed; odoriferous orifice lying pre-apically in a semicircular notch at the posterior margin of the broad, elevated ridge which terminates abruptly about midway on the pleurum; first and second segments of the posterior tarsus together much longer than third segment. Hussey (Jn. N. Y. Ent. Soc. XXXIII: 63, 1925) has further diagnosed this genus in which he includes *Geocnethus cavicollis* Blatch, from Florida.

Geocnethus cubensis, new species

Black, shining; subcostal area of corium, femora, and tibiae castaneous; antennae, rostrum, and tarsi testaceous.

Head one-third wider than long, evenly semicircularly rounded in front; tylus as long as juga; edge smooth, calloused, not impressed or reflected; surface impunctate; base of tylus and juga faintly wrinkled, each of the latter provided with three long erect setae situated as follows: one near the center just before the middle, one near lateral margin just before the eye, and the third midway near inner margin of eye; also a submarginal pair below head projecting anteriorly; vertex somewhat elevated; ocelli five or six times as remote from each other as each is distant from eye; ocular seta short. Bucculae evenly elevated, reaching base of head, distinctly punctate. Rostrum with apex extending to middle of intermediate coxae; second and third segments nearly equal; fourth one-third shorter. Antennae with more slender second segment a little longer than third; last three segments finely pilose, somewhat more incrassate; fourth and fifth nearly equal, each one-third longer than third. Pronotum with the lateral margins gently rounding, the edge narrowly impressed throughout; submargin provided with five setigerous punctures, three anteriorly and two just behind the middle; dorsal surface smooth; anterior submargin in female distinctly depressed; nearly impunctate, a setose puncture near each anterior angle; a cluster of three or four near anterior margin directly back of ocelli; a few punctures across the disk behind the middle where it is not at all impressed. Scutellum one-fifth longer than wide; apical sixth narrow, rounded at apex; narrowly depressed and with a linear row of punctures along margins; smooth across basal portion preceded by a row of punctures at extreme depressed basal margin; disk very sparsely coarsely punctate. Hemielytra with clavus provided with a single row of coarse punctures; corium with a single row of punctures paralleling the claval suture, with another incomplete row paralleling these becoming obsolete posteriorly; disk of mesocorium otherwise impunctate; subcostal nerve linearly punctate on each side; subcostal region (exocorium) impunctate, narrow at basal fourth, thence gradually widening posteriorly where it is subparallel to costal margin; edge of costa with two widely separated setigerous punctures. Membrane sordid white, clouded with fuliginous towards base. Pleura

almost impunctate; mesosternum carinate; metapleural odoriferous orifice as discussed in generic diagnosis. Legs with anterior coxae setose at apices; anterior femora somewhat incrassate, flattened below, with five or six minute setose tubercles along anterior lower edge and from four to five long setae along the posterior edge; anterior tibiae outwardly armed with five to six spines, increasing in length apically, inwardly armed with a single long preapical spine and several more at apex; intermediate and posterior femora somewhat compressed, sparsely setose, and armed below with a row of fine short spines, tibiae cylindrical, uniformly long-spinose; basal segment of posterior tarsus nearly twice as long as the apical two united. Venter smooth, nearly impunctate; second abdominal segment at base distinctly and apical margins of segments 2–4 faintly carinulate; segments 2–6 laterally provided with two long setose hairs; lateral margin of sixth segment just behind middle armed with a bristle or slender spine. Male hypopygium (seen from below) obtusely rounded, entire. Length 6 mm.

Type, male: Cayamas, Apr. 3 (E. A. Schwarz)—U. S. N. M. *Paratype, female:* Sierra Rangel, Aug. 28, 1929 (J. Acuña and S. C. Bruner)—Est. Exp. Agron. Cat. No. 44043, U. S. N. M.

This has been wrongly determined as *Pangaeus piceatus* Stal and probably is the species so labeled in the Gundlach collection. What we have taken as the paratype differs in several respects from the type as follows: the pronotum just back of the anterior margin has distinct transverse depression, about as long as the space between the ocelli, and a distinct setigerous pit just in front and near the outer limits of this depression; the disk behind the middle has several faint transverse furrows; the sides of the venter are provided with a cluster of small punctures before and behind each spiracle.

Geocnethus reversus new species

Plate XXV, Fig. 1

Black, highly polished. Antennae and rostrum embrowned; tarsi testaceous, remainder of legs castaneous.

Head bluntly, semicircularly rounded; three-sevenths wider than long; lateral submargins lightly impressed and very slightly reflexed; tylus contracted anteriorly; surface of lateral lobes irregularly, faintly wrinkled and very sparsely punctate; each of these provided with six long erect setae placed as follows: four along the submargin, one anteriorly in the center of the lobe and another near the inner margin of the eye, all set in enlarged pits; ocelli five times as far apart as each is removed from eyes; ventral submargin with two long, porrect setae. Antennae 1.44 mm. long, apex of basal segment just visible beyond margin of head; relative lengths of the segments as follows: I, .24; II, .2; III, .24; IV, .36; V, .4 mm. Rostrum reaching to middle coxae, second segment a little longer than third, fourth one-third shorter than third. Pronotum about three-sevenths wider than long; lateral margins, seen from above, gently rounding anteriorly; submargin beset with five long setae; anterior disk impunctate, laterally coarsely and sparsely punctate; anterior submargin furnished with a tranverse series of 14–19 coarse punctures, terminating back of each eye

in a prominent setigerous pit, another setigerous pit at each anterior angle; a transverse row of coarse punctures a little behind middle, with a few scattered ones behind this on the central disk. Scutellum one-seventh longer than wide, smooth anteriorly, sparsely and coarsely punctate posteriorly; a line of closely set punctures along the margins. Corium with two rows of punctures paralleling the claval suture; mesocorium anteriorly with a short, longitudinal row, elsewhere with a few scattered punctures; subcostal region and outer apical angles rather closely punctate; costal margin with two widely separated setigerous punctures. Membrane lightly infumed. Ventral segments smooth, with a few punctures about the spiracles; anterior margin of segments furnished with a line of punctures (carinulate). Anterior femur and tibia as shown in the drawing. Length 5 mm.; humeral diameter 2.5 mm.

Type male: Mayagüez, Puerto Rico, IX, 10, 1930 (Coll. by L. L. Martorell). *Paratype, male:* Mayagüez, Puerto Rico, IX, 15, 1930 (Coll. by A. Suro); *Paratype, female:* 1 Isabella, Puerto Rico, IV, 14, 1930 (Coll. by M. D. Leonard at light); 1 Río Piedras, Puerto Rico, XII, 21, 1911; 2 Cayamas, Cuba (Coll. by E. A. Schwarz). All in the collection of the U. S. National Museum. Cat. No. 44044, U. S. N. M.

This is about the size and general appearance of *Aethus indentatus* Uhler, with which it has been confused. The absence of marginal spines of the head and the character of the punctuation of the pronotum will serve to differentiate it. It is somewhat smaller than *G. cubensis* n. sp. with relatively much shorter antennae, the anterior submargin of pronotum and corium more profusely punctate.

Geotomus spinolai Signoret

1863. Signoret, Ann. Soc. Ent. Fr., p. 545; Pl. 12, Fig. 2.

One specimen labeled Cuba in the U. S. National Museum is in poor condition.

Signoret remarks that this is distinguishable from all of the related forms by the fact that neither the lateral nor the median lobes of the head have the usual setae, and they have a line of strong punctures in the marginal space.

Amnestus pusillus Uhler

1875. Uhler, Bull. Geol. Geogr. Surv. I: 278; III: 371 (1878).

1883. Signoret, Ann. Soc. Ent. Fr., 372; Pl. 10, Fig. 197.

Recorded by both Uhler and Signoret from Cuba and Texas. Now known to be widely distributed in the United States. The authors have not seen this species from Cuba, and all of the specimens from that island remaining in the Uhler collection at the U. S. National Museum belong to the next species. Specimens of *pusillus* from

Texas are ochraceous yellow in color with the fore femora of the male usually having a small simple spine a short distance from the base; the hind femora armed with a very long spine nearly half as long as the tibia; hind tibia curved and finely serrate toothed along the inner edge; the anterior margin of the pronotum more strongly concave than in *pusio* for the reception of the head.

Amnestus pusio Stal

1858. Stal, Bidrag till Rio Jan. Hem. I: 14.

1883. Signoret, Ann. Soc. Ent. Fr. 373: Pl. 15, Fig. 199.

Vibora, Havana (Bruner); Sto. Tomás, P. de Zapata (Bruner and Acuña); Manacas, Sta. Clara (Bruner)—Est. Exp. Agron. Cayamas (Schwarz); Santiago (Morrison)—U. S. N. M. Recorded from Cuba by Signoret.

Of the same general color as the preceding but somewhat smaller. The fore and hind femora of the male each armed with a short spine, the former sometimes bifid; the hind tibia straight and not serrate toothed along inner edge; the anterior margin of the pronotum not so deeply concave for the reception of the head. According to Blatchley this species occurs in Florida and several specimens from Bedford City, Va., are in the collection of the National Museum.

Amnestus subferrugineus (Westwood)

1837. Westwood, in Hope Cat. I: 19.

1883. Signoret, Ann. Soc. Ent. Fr. 373; Pl. 10, Fig. 198.

Jarahoeca Ote. (Bruner)—Est. Exp. Agron. Specimens in the U. S. National Museum collection are from the West Indian islands St. Vincent, Grenada, San Domingo, Martinique, and Dominica.

This species is larger than the other two mentioned, averaging 2.5–3 mm. long and of a ferruginous or dark castaneous color on the head, pronotum, scutellum, and beneath: the hemielytra are paler with castaneous maculations. The disk of the anterior lobe of the pronotum is smooth, exhibiting a row of coarse punctures along the anterior margin. The anterior femora of the male have a prominent oblique bifid tooth and the posterior femora are armed with a rather long, sometimes curved, spine before the apex.

KEY TO CUBAN SPECIES OF AMNESTUS

1. Color ferruginous to dark castaneous; pale hemielytra marked with castaneous; anterior femora of male with a prominent bifid spine; anterior disk of pronotum smooth ---------------------- *subferrugineus* (Westw.)
   Color yellow ferruginous; anterior femora of male unarmed or with a small spine; anterior disk of pronotum punctate -------------------------- 2

2. Posterior femora of the male armed with a very long spine and the posterior tibia curved and serrate along inner edge; anterior margin of pronotum deeply concave---------------------------------------*pusillus* Uhler
   Posterior femora of male with a short, oblique spine and posterior tibia straight, not serrate, inwardly; anterior margin of pronotum not deeply concave. Smaller species------------------------------------*pusio* Stal

Family Pentatomidae

Subfamily Megaridinae

Megaris majusculus McAtee and Malloch

1928. McAtee and Malloch, Proc. U. S. Nat. Mus. LXXII, Art. 25, p. 6.

Novaliches, Guantánamo (C. T. Ramsden). Known only from the holotype which is in the collection of the American Museum of Natural History.

Subfamily Scutellerinae

KEY TO CUBAN GENERA OF SUBFAMILY SCUTELLERINAE

1. Venter devoid of a stridulating area on each side of the disk; ventral incisures gradually curved on central disk, abruptly arcuated before the lateral margins. Antenna with four segments; second segment very long in *A. illustris,* much longer than first. Odoriferous canal long and distinct. Scutellum entirely covering abdomen--------------------*Augocoris* Burm.
   Venter provided with a stridulating area on each side of the disk, at least occupying the fourth and fifth segments. Antenna with five segments--- 2
2. Pronotum with a distinct transverse impression near the middle. Head about as long as the pronotum, strongly convex------------*Camirus* Stal.
   Pronotum devoid of a transverse impression. Head shorter than pronotum-- 3
3. Odoriferous orifice placed as close to the lateral margin of the metapleurum as to the posterior coxae, or more remote from the coxae than from the lateral margin of the metapleurum, very rarely prolonged in a canal----- 4
   Odoriferous orifice more remote from the lateral margins of the metapleurum than from the posterior coxae, most often (except in *Diolcus*) prolonged in a canal--- 5
4. Scutellum not as wide as abdomen. Connexivum free. Head obliquely truncate anteriorly on each side. Pronotum and scutellum not spotted with red---*Tetyra* Fab.
   Scutellum as wide or very nearly as wide as abdomen. Connexivum not entirely free. Head entirely rounded anteriorly. Pronotum and scutellum spotted with red--------------------------------------*Pachycoris* Burm.
5. Odoriferous orifice not terminating in a canal. Anterior face of tibia with two longitudinal grooves separated by a median longitudinal ridge------ --*Diolcus* Mayr.
   Odoriferous orifice terminating in a distinct canal. Anterior face of tibia provided with a single wide, longitudinal groove---------------------- 6

6. Canal from odoriferous orifice gradually expanded outwardly and turned abruptly forward at a right angle before lateral margin of metapleurum. Sixth ventral segment of abdomen not twice as long through middle as along lateral margin .... *Sphyrocoris* Mayr.
Canal from odoriferous orifice straight, nearly transverse, the margins parallel. Sixth ventral segment of abdomen about twice as long through middle as along lateral margin .... *Symphylus* Dallas.

Tetyra antillarum Kirkaldy

1794. *arcuatus* (Fabricius), Ent. Syst. IV: 83.

1909. *antillarum* Kirkaldy, Cat. Hem.-Cim. 284 (new name).

Soledad (Myers)—M. C. Z. San Blas, Santa Clara Prov. (G. H. Rowe)—Est. Exp. Agron.

A species fully as large as *T. bipunctata* H. S., from which it may be distinguished structurally by the following differences: a little more depressed; head relatively shorter with lateral margins before eyes more strongly sinuate; lateral margins of pronotum more evidently sinuate. The antennae are usually distinctly banded with yellow and black.

Pachycoris fabricii (Linnaeus)

1771. Linnaeus, Mant. Plant. II: 534.

1863. *Pachycoris wilsoni* Uhler, Proc. Ent. Soc. Philad. II: 159.

Soledad (Myers)—M. C. Z. "Cuba" (Uhler Coll.—U. S. N. M.)

Uhler's type of *wilsoni*, a female, is in the collection of the National Museum, also a male labeled "Cuba"—"Gundlach" in Uhler's well known hand. The male specimen lacks the two yellow patches on the head and the yellow maculations below are reduced to only the outer apical angle of the metapleurum and a small spot on either side of the fifth and sixth abdominal segments. We conclude that *wilsoni* is only a color form of the West Indian *fabricii*. It was reported from Cuba by Guérin as *Scutellera (Pachycoris) nitens* Dallas.

Diolcus boscii (Fabricius)

1798. Fabricius, Ent. Syst. Suppl. 529.

1868. *Symphylus politus* (Walker), Cat. Hem. III: 518.

Taco Taco (Bruner, Acuña, and Ballou); Santiago de las Vegas (Acuña and Bruner); Camagüey (Acuña); Viñales (Bruner)—Est. Exp. Agron. Soledad (Myers and Salt)—M. C. Z.

Recorded from Cuba by Guérin. It may be readily distinguished from the other species of the genus by the longer rostrum which reaches well behind the posterior coxae; abdomen ventrally deeply sulcate in front; golden green punctures dorsally and ventrally; also with more or less distinct irregular pale dots on scutellum.

Diolcus variegatus (Herrich-Schaeffer)

1836. Herrich-Schaeffer. Wanz. Ins. III: 106, Fig. 332.

Manzanillo (Bruner and Ballou); Viñales (Bruner); Santiago de las Vegas (Barreto); Camagüey (Acuña); Palmira (Ballou); Itabo (Cardín)—Est. Exp. Agron. Soledad (Myers)—M. C. Z. Cayamas (Schwarz); San Blas de Río (Mann); Central Jaronú (Scaramuzza); Baraguá (Scaramuzza)—U. S. N. M.

Diolcus irroratus (Fabricius)

1775. Fabricius. Syst. Ent. 699.

1923. *D. boscii* Barber (nec Fab.), Amer. Mus. Nov. No. 75: 12.

Camagüey (Acuña); Cojimar (Bruner); Hoyo Colorado (Enamorado)—Est. Exp. Agron. Baraguá (Scaramuzza)—U. S. N. M. Guérin reported this from Cuba; it is much less numerous there than either of the foregoing species of *Diolcus.*

KEY TO SPECIES OF DIOLCUS FROM CUBA AND UNITED STATES

1. Head longer, very nearly as long as wide, not punctate to extreme edge. Lateral margin of the pronotum slightly concavely arcuate before the middle. Venter shallowly grooved anteriorly. Antennae basally pale, apically banded with black. Not punctate with green---------*variegatus* (H. S.)

   Head shorter, nearly one-third or more wider than long, as seen dorsally punctate to extreme edge. Lateral margins of pronotum either straight or lightly convexly arcuate. Antennae pale or very lightly tinted with brown -- 2

2. Lateral margins of pronotum straight, humeri obtusely angled. Head, pronotum, scutellum, and corium punctate with green. Venter smooth, with a few scattered brown and green punctures; a deep groove anteriorly running to middle of the fourth segment----------------*boscii* (Fab.).

   Lateral margins of the pronotum lightly convexly arcuate; humeral angles more rounded. Venter with the first three segments shallowly grooved--- 3

3. Head relatively shorter and broader, three-fifths wider than long, forming with the two lateral lobes a bluntly rounded apex. Pronotum punctate to edge; conspicuous greenish punctures on head and pronotum. Scutellum laterally furnished with a round black spot. Venter profusely punctate on both sides of middle. (Florida, Texas, etc.)----*chrysorrhoeus* (Fab.).

   Head relatively longer, somewhat over one-fourth wider than long, forming with the two lateral lobes a more acute angle. Not punctate with green. Pronotum not punctate along pale, lightly reflexed lateral margins. Venter smooth, with large scattered brown punctures----------*irroratus* (Fab.).

Sphyrocoris obliquus (Germar)

1839. Germar, Zeits. Entomol. I: 94.

Manzanillo (Bruner and Ballou); Santiago de las Vegas (Bruner, Barreto, and Acuña); Isla de Pinos (Ballou); Sierra Rangel

(Acuña and Bruner); Camagüey (Acuña): Puerto Tarafa (Bruner); Baraguá (Stahl and Bruner)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Jababo (Scaramuzza); Central Jaronú (Stahl); "Cuba" (Uhler)—U. S. N. M.

This is a common species throughout the West Indies, southern Florida, Mexico, Central America, and Colombia. In this genus the sulcus from the odoriferous orifice is apically abruptly bent forward at a right angle and expanded into a punctate area. Guérin first reported this species from Cuba.

Symphylus caribbeanus Kirkaldy

1857. *Scutellera obliqua* (Guérin), La Sagra, Hist. Cuba. Ins. 362 (not Germar).

1909. *Symphylus caribbeanus* Kirkaldy (new name), Cat. Cim. 280.

1914. *Symphylus deplanatus* Barber, Bull. Am. Mus. Nat. Hist. XXXIII: 526 (not Herrich-Schaeffer).

1926. *Symphylus deplanatus* Blatchley, Heterop. E. No. Amer. 43 (not Herrich-Schaeffer).

Nagua, Oriente (Bruner and Ballou); San Nicolás, Oriente (Bruner); Sierra Rangel, Pinar del Rio (Hermano Roberto)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. "Cuba" as *Mesotrypa sinuosa* Uhler—U. S. N. M.

This variably marked species also occurs in Florida from whence it was differentiated by Hart and Malloch as *Symphylus* sp. (Bull. Nat. Hist. Surv. Ill. 171, 1919) to distinguish it from *Stethaulax marmoratus* Say with which it had been confused. The specimens in the National Museum collection from Ft. Valley, Ga., referred to *Symphylus deplanatus* by Professor Blatchley, are all *Stethaulax marmoratus*. *Symphylus caribbeanus* differs from the foregoing species by having the head more acutely produced anteriorly. It may be well to remark in this connection that after a careful comparison of a long series of *Stethaulax* from the United States with several Neotropical species of *Symphylus* we have come to the conclusion that the former is not deserving of generic rank and that the two genera should be combined. The bisulcate tibia, the only character relied upon for differentiating *Stethaulax*, is not at all evident. *Symphylus deplanatus* H. S. differs from *caribbeanus* in its greater size and more plainly impressed, recurved margins of the pronotum.

Camirus porosus (Germar)

1839. Germar, Zeitschr. Entom. I: 108.

Camagüey (Acuña)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Cayamas (Schwarz)—U. S. N. M.

The only species of the genus found in Cuba. It is dull black, densely punctate above and below, with the exception of the stridulating areas on the venter. The odoriferous orifice or osteole is not continued in a groove, and the pronotum has a distinct transverse impression near the middle. About 4 mm. long.

Augocoris illustris (Fabricius)

1781. *Cimex sexpunctatus* Fabricius, Spec. Ins. II: 339 (name preoc.).

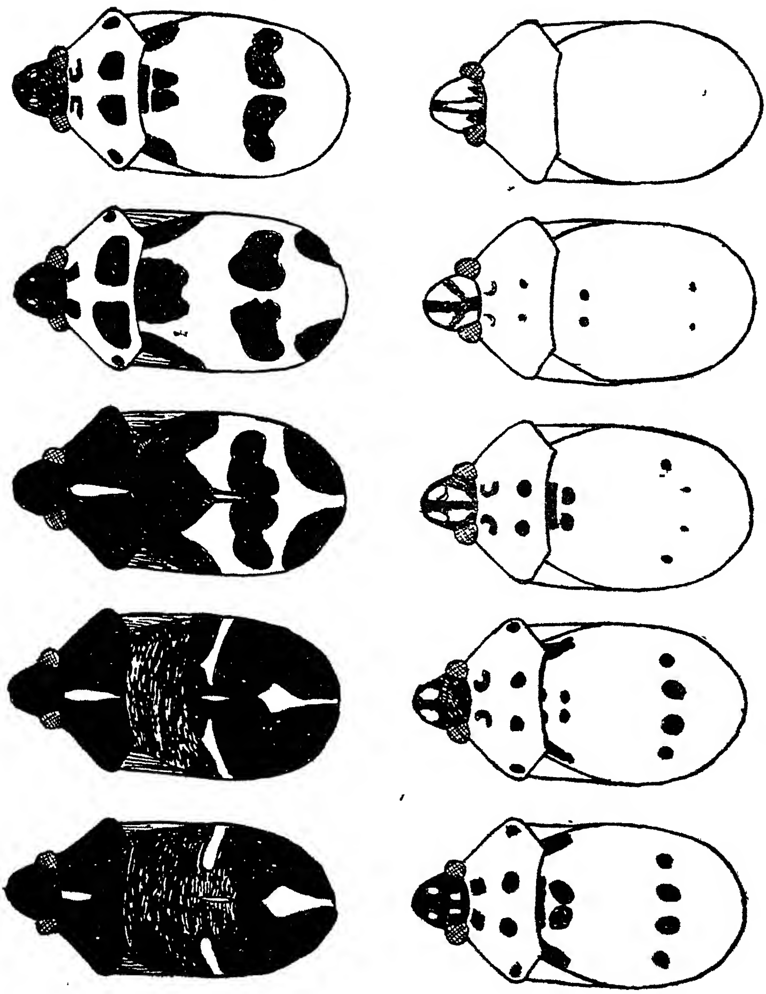
1781. *Cimex illustris* Fabricius, Spec. Ins. II: 340.

1863. *Augocoris poeyi* Uhler, Proc. Ent. Soc. Philad. II: 158.

Camagüey (Acuña); Santiago de las Vegas (Barreto, M. Plasencia); Taco-Taco (Acuña)—Est. Exp. Agron. Jobabo (Stahl); "Cuba" (Uhler coll.)—U. S. N. M.

A large species 13–17 mm. long, which shows a most remarkable variation in both color and form. At one extreme the insect is black above, slightly purplish, marked with orange red as follows: a longitudinal median vitta on pronotum; three maculae on scutellum, two roughly triangular ones on either side before center, and a larger sagittate macula behind, the point touching apical margin. Below, this form is entirely black except the abdomen which is orange red marked with black as follows: the genital segment, the central portion of the sixth segment, and a large subquadrate spot on either side of the remaining segments; also a similar series of spots above almost covering the connexivum. The tibiae and antennae are washed with dark metallic purplish or greenish blue. *A. poeyi* Uhler is near this form but the red markings are larger. The anterior and posterior edges of the postpectus and the exterior edge of the scutellum are not white, however, in our specimens, although rather pale in some of them. At the other extreme the species is largely testaceous to ivory white, sometimes washed with brownish above, with no black except for fusco-piceous markings on head and a rounded spot on either side of the second ventral segment just below the spiracle. This spot and the metallic greenish or purplish blue tibiae and antennae are constant for all varieties but less noticeable on the very dark forms. The femora of the paler forms are rich brownish yellow.

Between these two extremes there are numerous variations com-



Series of *Augocoris illustris* showing variation.

bining orange or orange red, clay yellow, and black, but following the same general pattern.

More remarkable still is the variation in morphology shown by this species. The dark form is very coarsely rugose above, transversely so on pronotum and anterior portion of scutellum, the latter being strongly and irregularly sculptured behind. This form is probably the same as *A. rugulosus* H. S. The other extreme, the pale variety, has both the pronotum and scutellum perfectly smooth. These two extremes blend one into the other through intermediate forms. This is well demonstrated by a series of 20 specimens reared by Mr. J. Acuña at Camagüey, Cuba, from a single group of freshly hatched nymphs found on a Sapotaceous tree, *Chrysophyllum oliviforme* Lin., the only plant on which this insect has so far been observed in Cuba.

In the National Museum collection there is a specimen from Puerto Rico which agrees with the dark variety of this species from Cuba. No specimen of *A. poeyi* identified by Uhler is in the National Museum collection.

Augocoris illustris has a wide distribution from Mexico through Central and South America as far south as the Argentine Republic. Guérin reported it from Cuba as *Scutellera (Augocoris) cretacea* Voet. and *pallida* Pal. Beauv., both being color varieties of this species.

Subfamily GRAPHOSOMATINAE

Amaurochrous dubius (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. p. 33, Pl. VI, Fig. 6 (Podops).

Described from Cuba. In the National Museum collection there are two specimens from Florida, one from Georgia, and one from Cuba. It is considerably larger than *cinctipes* Say and differs from that species in the much more produced processes of the anterior angles of the pronotum which project well beyond the line of the eyes.

Subfamily PENTATOMINAE

KEY TO CUBAN GENERA OF SUBFAMILY PENTATOMINAE

1. Basal segment of rostrum not inserted near front of bucculae, set behind middle of head, and apex extended far behind base of head. Rostrum very long, nearly reaching to apex of abdomen. Scutellum extended nearly to apex of abdomen ________ *Coriplatus* White.
   Basal segment of rostrum inserted near front of bucculae, apex never extended far beyond base of head. Scutellum mediocre ________ 2

2. Lateral lobes (jugae) of head preapically toothed or obtusely angled. Lateral margins of pronotum armed with stout teeth. Head nearly or quite as long as pronotum. Bucculae extended to base of head------ --*Brochymena* A. and S.
   Lateral lobes of head not furnished with a preapical tooth or obtusely angled. Lateral margins of pronotum either serrate or smooth, rarely armed with teeth *(Neopharnus)*. Bucculae variable------------------ 3
3. Lateral lobes (jugae) of head acute at apices, surpassing tylus but not contiguous before it. Humeral angles of pronotum acute or acutely spinose--- 4
   Lateral lobes of head (jugae) most commonly obtuse anteriorly or if acute then the tylus much longer than jugae *(Proxys)*---------------------- 5
4. Second ventral segment of abdomen produced in a distinct anteriorly directed spine. Mesosternum with a strongly elevated longitudinal median carina ---*Arvelius* Spin.
   Second ventral segment of abdomen not produced in a distinct spine. Mesosternum with a low median carina. Apex of femora armed above with a minute spine--*Loxa* A. and S.
5. Metasternum provided with a large, smooth, flattened plate, bifid or notched posteriorly to receive the abdominal process from the second ventral segment. Lateral lobes (jugae) of head apically contiguous or nearly so-- 6
   Metasternum devoid of smooth plate; posterior coxae contiguous or nearly so. Lateral lobe of head more rarely contiguous--------------------- 9
6. Rostrum short, apex most commonly not extended beyond anterior notch of metasternal plate; basal segment not extended behind base of head. Metasternal plate extended anteriorly to at least the middle of the mesosternum and distinctly bifid anteriorly. In Cuban species humeral angles not at all prominent-------------------------------------*Edessa* Fab.
   Rostrum long, extended onto venter of abdomen; basal segment surpassing bucculae and extended beyond base of head. Metasternal plate but slightly extended anteriorly on the mesosternum, obtusely concave before. Humeral angles prominent. Body less convex ventrally---------------- 7
7. Lateral margins of pronotum with several long teeth. Dorsal parts distinctly pilose----------------------------------*Neopharnus* Van Duz.
   Lateral margins of pronotum unarmed. Dorsal parts not pilose----------- 8
8. Lateral margins of pronotum straight. Third segment of rostrum much longer than second. Second and third segments of antenna subequal-- --*Praepharnus* n. g.
   Lateral margins of pronotum more or less concavely sinuate. Second segment of antenna much shorter than third----------------*Pharnus* Stal.
9. Second ventral segment of abdomen produced anteriorly in a distinct spine or well defined tubercle--- 10
   Second ventral segment of abdomen neither produced in a distinct spine nor definite tubercle--- 16
10. Spine of second ventral segment of abdomen long, surpassing posterior coxae --- 11
   Second ventral segment of abdomen either armed with a shorter spine or only with a well defined tubercle---------------------------------- 12

11. First antennal segment extended beyond margin of head. Connexivum of abdomen widely exposed and alternately banded with red and black. 18 mm. long---*Vulsirea* Spin.
 First antennal segment not reaching to margin of head. Connexivum of abdomen not at all or narrowly exposed, unicolorous. 10 mm. long or less---*Piezodorus* Fieb.

12. Lateral margins of pronotum very strongly, concavely sinuate; humeral angles bluntly prominent, rounded. First antennal segment surpassing margin of head. Ventral abdominal spine attaining middle of posterior coxae. Anterior tibiae distinctly, longitudinally sulcate---*Modicia* Stal.
 Lateral margins of pronotum most commonly nearly straight, if strongly convex then the humeral angles very acute or spinose---------------- 13

13. Second ventral segment of abdomen armed with a distinct spine either projected between the posterior coxae or at least somewhat produced and subacute. Canal from odoriferous orifice long and attenuated, tapering to a very acute point reaching nearly as far as posterior lateral angle of mesopleurum. Cuban species pure green----------*Acrosternum* Fieb.
 Second ventral segment of abdomen elevated in a well defined obtuse tubercle--- 14

14. Canal from odoriferous orifice short, not reaching to middle point of metapleurum; margins of canal elevated. Cuban species clear green---*Nezara* A. and S.
 Canal from odoriferous orifice long and attenuated, acute apex reaching nearly as far as posterior lateral angles of mesopleurum-------------- 15

15. Anterior tibia distinctly, longitudinally sulcate. Head across eyes wide, more than one-half the greatest diameter of the pronotum. Second segment of antenna much longer than one-half the length of fifth segment. Anterior margin of pronotum calloused. Lateral margin of pronotum, anteriorly, distinctly impressed-------------------------*Pallantia* Stal.
 Anterior tibia obsoletely or not at all sulcate longitudinally. Head across eyes distinctly less than one-half the greatest diameter of the pronotum. Second segment of antenna about one-half the length of fifth segment. Anterior margin of pronotum not calloused---------------*Banasa* Stal.

16. Head long, not immersed to eyes; tylus very acutely produced before the jugae. Humeral angles of pronotum very acutely or spinously produced. Odoriferous orifice not produced in an evident canal----*Proxys* A. and S.
 Head immersed to eyes; tylus neither acute nor much produced before jugae--- 17

17. Odoriferous orifice terminating in a long, attenuated, acute canal, reaching halfway or more to margin of metapleurum------------------------ 18
 Odoriferous orifice either devoid of a canal or with a very short one not reaching halfway to margin of metapleurum---------------------- 19

18. Anterior and lateral margins of pronotum strongly impressed and reflexed or elevated. Pleura and venter very obsoletely punctate, shining. Brightly colored, red and black---------------------------------*Arocera* Spin.
 Anterior and lateral margins of pronotum scarcely impressed and not reflexed. Dorsal and ventral parts distinctly and profusely punctate, scarsely shining. Green species--------------------------*Thyanta* Stal.

19. Odoriferous orifice set almost between the outer limits of the middle and posterior coxae, not terminating in a canal. Variegated species-- *Murgantia* Stal.

Odoriferous orifice more remote from coxae, either terminating in a canal or merely auriculate exteriorly-- 20

20. Bucculae rather short, extending as far as anterior margin of eyes; basal segment of rostrum much extended beyond bucculae. Basal segment of antenna extending beyond margin of head. Anterior and lateral margins of pronotum strongly impressed and reflexed. Canal from odoriferous orifice distinct but short, not reaching to middle of metasternum; abruptly terminating; margins calloused. Large red and black species-- *Eunibia* Stal.

Bucculae extending to base of head or very nearly so; basal segment of rostrum most commonly not much longer than bucculae. Anterior and lateral margins of pronotum not strongly impressed or reflexed. Odoriferous orifice auriculate exteriorly without a distinct canal------------ 21

21. Anterior tibia provided with a distinct, wide, longitudinal sulcus. Lateral margins of pronotum, at least anteriorly, denticulate or crenulate-- *Euschistus* Dall.

Anterior tibia either devoid of a longitudinal sulcus or with a very narrow one--- 22

22. First segment of rostrum not longer than bucculae. Head as long or very nearly as long as pronotum. Anterior disk of pronotum devoid of a smooth, calloused, yellow spot on each side------------ *Solubea* Bergr.

First segment of rostrum somewhat longer than bucculae, the latter more elevated. Anterior disk of pronotum with a smooth, calloused, yellow spot on each side---------------------------------- *Mormidea* A. and S.

Coriplatus depressus White

1842. White, Trans. Ent. Soc. Lond. III: 90.

"Cuba"—U. S. National Museum in the Uhler collection.

A new record, as this has hitherto been recorded only from British Guiana and Colombia. It is a very flattened hemipteron with a long head, in which the juga meet well before the tylus; the margins of the pronotum are provided with three large spines; the scutellum is spatulate, very long, reaching to the apex of the abdomen; the rostrum reaches, or nearly reaches, the apex of the abdomen, the venter of which is longitudinally sulcate.

Brochymena poeyi Guérin

1857. Guérin in La Sagra, Hist. Cuba, Ins. 365; Pl. XIII, Fig. 1.

Santiago de las Vegas (Barreto, Bruner, Acuña, and Otero); Casa Blanca (Bruner); Hoyo Colorado (Enamorado); Havana Prov. and Los Palacios (Betancourt, Acuña, and Barreto)—Est. Exp. Agron. "Cuba"—U. S. N. M. Also recorded by Gundlach from eastern Cuba.

Very clearly related to *arborea* but differs from that species by

having the truncated humeral angles slightly more projecting; teeth along the lateral margins of the pronotum fewer and more irregular; lateral margins of the head anteriorly more converging; subapical tooth less pronounced; bases of antennal segments 2–5 distinctly and widely pale ringed.

Mormidea pictiventris Stal

1862. Stal, Stett. Ent. Zeit. XXIII: 103.

Santiago de las Vegas (Cardín, Houser, and Bruner); Camagüey (Acuña); Palmira (Ballou); Nagua, Oriente (Bruner and Ballou); Las Animas, Sierra Rangel, Pinar del Rio (Cardín, Houser, and Bruner); El Cobre (Bruner); and Santa Bárbara, Isle of Pines (Bruner)—Est. Exp. Agron.

This is a common and widely distributed species from Mexico south through Central America to Colombia and the West Indies. It is a fuscous or fusco-ferruginous species on which the pale calloused markings are very conspicuous. The submarginal vittae of the scutellum extend posteriorly as far as the frena; the humeral angles are not at all prominent. It has much the appearance of *Mormidea lugens* Fab.

Mormidea cubrosa Dallas

1851. Dallas, List Hem. I: 247.

1872. *Mormidea sordidula* Stal, Enum. Hem. II: 21.

Santiago de las Vegas (Bruner); Nagua, Oriente (Bruner and Ballou); El Cobre, Oriente (Silvestri and Bruner); Jarahueca, Ote. (Bruner); Nueva Gerona, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron.

Stal described *sordidula* from Texas. Comparison of specimens from that state with those from Cuba and Jamaica shows that they are the same and answer to Dallas's description of the species from Jamaica. There is little question that Stal's name will have to be treated as a synonym. This is a rather small ferruginous species with the pale markings of the scutellum much reduced.

Mormidea angustata Stal

1862. Stal, Stett. Ent. Zeit. XXIII: 102.

Taco-Taco (Bruner, Acuña, and Ballou); Camagüey (Acuña); Puerta de Golpe, Pinar del Rio (Houser); Santa Fe and Columbia, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. McKinley, Columbia, and Nueva Gerona, Isle of Pines (Link)—U. S. N. M.

Described from Mexico and a fairly common species in Central America. Heidemann recorded it from the Isle of Pines. It is a

paler, more ferruginous punctate species than *pictiventris* Stal, and the submarginal calloused vittae of the scutellum extend as far as the frena; costal margins of the corium frequently reddish; humeri either spinose or angulated. There is some question as to whether or not this is a synonym of *M. scutellata* Westwood, which it may very well be.

Mormidea albisignis Stal

1872. Stal. Enum. Hem. II: 220.

Baracoa and Nagua, Oriente (Bruner and Ballou); Sierra Rangel, Pinar del Rio (Acuña and Bruner): Santiago de las Vegas (Bruner); "El Hospital," Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. La Milpa, Cienfuegos (Salt)—M. C. Z. Near Viñales—A. M. N. H. Baraguá (Plank); Cayamas (Schwarz)—U. S. N. M.

This species described from Cuba, measures 5–6 mm. in length. It resembles rather closely *M. ypsilon* (Linn.) in its general color and markings. Stal states that the second and third antennal segments are equally long, but in most of the specimens before us the second is slightly longer than the third segment. The humeri may be either rounded or spinose. Guérin lists *M. ypsilon* from Cuba but we have not seen it from that island.

KEY TO CUBAN SPECIES OF MORMIDEA

1. Apical angles of sixth abdominal segment of male and seventh of female plainly spinose; humeral angles variable, either spinose or obtuse ------- 2
   Apical angles of sixth abdominal segment of male and seventh of female sometimes acute but not spinose; humeral angles always obtuse or rounded 3
2. Posterior margin of the male hypopygium strongly concavely sinuate in the middle; tylus not extended beyond apices of juga; membrane vitreous; submarginal calloused vittae of scutellum extended to frena, not incurved posteriorly; pleura each marked with a small black spot; venter nearly or quite immaculate; ferruginous punctate species with wide costal margins often reddish ------------------------------------ *angustata* Stal.
   Posterior margin of the male hypopygium feebly concavely sinuate in the middle; tylus slightly extended beyond apices of juga; membrane embrowned; submarginal calloused vittae of the scutellum not as long as frena, these incurved, contiguous or nearly so about the middle of scutellum; beneath devoid of broad black stripes. Heavily infuscated species -- *albisignis* Stal.
3. Posterior margin of the male hypopygium strongly concavely sinuate in the middle; membrane embrowned; submarginal calloused vittae of the scutellum extended as far as the frena; sternum black; pleura heavily and venter trivittate with fuscous. Fuscous or fusco-ferruginous species---- -- *pictiventris* Stal.

Posterior margin of the male hypopygium feebly concavely sinuate in the middle; membrane vitreous; scutellum with a small, yellow, calloused spot in each basal angle which is rarely extended into vittae; marked beneath much as in preceding species. Ferrugino-griseous species------ --- *cubrosa* Stal.

Solubea pugnax (Fabricius)

1775. Fabricius, Syst. Entom. 704.

Los Palacios (Betancourt); Sierra Rangel, Pinar del Rio (Acuña and Bruner); Santiago de las Vegas, Havana Prov. (Plá, Barreto, and Bruner); Cunagua and Holguin, Oriente (Bruner); Palmira (Ballou); Bahía de Cochinos, Santa Clara (Bruner); Camagüey (Acuña); Baraguá, Camagüey Prov. (Stahl and Bruner); Holguin, Oriente Prov., and Manzanillo (Bruner and Ballou)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Cayamas (Schwarz)—U. S. N. M. San Carlos Est., Guantánamo and near Viñales—A. M. N. H.

A common species in Cuba and other West Indian Islands and differing in no respect from specimens taken in our southern states. Recorded from Cuba by Guérin as *Pentatoma (Mormidea?) typhoeus* Fab.

Solubea insularis (Stal)

1872. Stal, Enum. Hem. II: 22.

1857. *Pentatoma (Mormidea) geographica* Fabricius (var.), Guérin in La Sagra, Hist. Cuba Ins. 369.

1893. *Mormidea guerini* Lethierry and Severin, Cat. Gen. Hem. I: 123 (new name).

1902. *Oebalus insularis* var. *similis* Kuhlgatz, Berl. Ent. Zeit. 253.

Santiago de las Vegas (Bruner); Las Animas, Sierra Rangel, Pinar del Rio (Houser, Hutson, Cardín, Acuña, and Bruner); Hoyo Colorado, Havana Prov. (Enamorado and Bruner); Palmira, Santa Clara Prov. (Ballou); Nueva Gerona, Isle of Pines (Bruner and Boucl é)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Jatibonico and Baraguá (Scaramuzza); Santiago de las Vegas (Cardín); Cayamas (Schwarz); Havana—U. S. N. M. Pinar del Rio—A. M. N. H.

Specimens of this same species are contained in the collection of the National Museum from Florida, Mexico, Honduras, Panamá, and Haití. In spite of its appearance it belongs to *Solubea* rather than *Mormidea* from the fact that the basal segment of the rostrum does not exceed the bucculae, the fore tibia are sulcate as in *S. pugnax* (Fab.), and the pronotum lacks the usual calloused spots. Some color varieties of it may be very easily confused with *Mormidea ypsilon* (Linn.) as was evidently the case with Guérin, who records that

species from Cuba. It varies in color from ferruginous to dark castaneous. The scutellum is particularly variable, being frequently with little or no evidence of calloused spots or more or less completely covered with smooth, calloused, yellow spots. This latter form Kuhlgatz described as var. *similis* from Colombia. The humeral angles are sometimes spinose. The hypopygium of the male has a distinct central lobe as noted by Stal. This is the species recorded by the senior author in his Florida List as *Mormidea guerini* Leth. and Sev. and is so treated by Blatchley in Heteroptera of Eastern North America.

Solubea linki (Heidemann)

1917. *Mormidea linki* Heidemann Ann. Carnegie Mus. XI: 351.

Calabazar, Havana Prov. (Bruner); Bahía de Cochinos, Santa Clara Prov. (Bruner); Baraguá, Camagüey Prov. (Stahl and Bruner); El Cobre and Manzanillo, Oriente Prov. (Ballou and Bruner); Los Indios and El Hospital, Isle of Pines (Bruner and Boucle)—Est. Exp. Agron. Columbia, Isle of Pines (Link); Havana and Cayamas (Schwarz); Baraguá (Stahl); 12 miles north of Santiago (Morrison)—U. S. N. M. Near Pinar del Rio—A. M. N. H.

This is much smaller than the other two species mentioned, in which the basal segment of the rostrum does not exceed the bucculae, and thus it is included in *Solubea* rather than in *Mormidea* where it was first placed by Heidemann. It differs from the other two species in that the anterior tibia is not sulcate. The humeral angles may be either angulated or spinose. It does not approach *Mormidea ypsilon* (Linn.) in structure or appearance as stated by Heidemann.

KEY TO CUBAN SPECIES OF SOLUBEA

1. Humeri armed with long, anteriorly directed spines; anterior tibia longitudinally sulcate; spiracles black; posterior margin of male hypopygium (ventral view) concave. Large species, 10–12 mm.------*pugnax* (Fab.).
   Humeri either angled or shortly spinose; posterior margin of male hypopygium (ventral view) lobate in the center; smaller species, not over 8–9 mm. -- 2
2. Lateral margins of pronotum very lightly concavely arcuate; humeri either angled or spinose; anterior tibia longitudinally sulcate; spiracles not black; posterior margin of male hypopygium very strongly lobate in the center--*insularis* (Stal).
   Lateral margins of pronotum strongly concavely arcuate and slightly crenulate; humeral angles shortly spinose; anterior tibia not longitudinally sulcate; spiracles black; posterior margin of male hypopygium much more feebly lobate in the center-------------------------*linki* (Heid.).

Euschistus acuminatus Walker

1867. Walker, Cat. Hem. Het. II: 246.

Nagua, Oriente Prov. (Bruner and Ballou) Taco Taco, Pinar del Rio Prov. (Ballou, Acuña, and Bruner); Santiago de las Vegas, Havana Prov. (Plá and Bruner), St. Tomás, Península de Zapata, Santa Clara Prov. (Bruner and Acuña); Camagüey, Camagüey Prov. (Acuña)—Est. Exp. Agron. Central Jaronú (Scaramuzza); "Cuba" (3 specimens labeled *E. thoracicus* Dallas var. by Uhler)—U. S. N. M.

This species was determined as *E. thoracicus* Dallas by Uhler and Gundlach but the specimens agree better with Walker's *acuminatus* described from San Domingo. "Thorax with a black hook-shaped mark on each side in front and with a black band between the spines which are black and slightly ascending, etc.", will serve to identify this species.

Euschistus crenator (Fabricius)

Plate XXV, Fig. 2

1794. Fabricius, Ent. Syst. IV: 101.

Viñales, Pinar del Rio Prov. (Bruner)—Est. Exp. Agron.

This species has been listed from Cuba as well as from other West Indian Islands. As it can be distinguished from *bifibulus* chiefly by comparative differences it is often confused with it. We have seen specimens from Dominica, Grenada, St. Croix, Jamaica, and Puerto Rico in the National Museum collection. The male hypopygium or genital segment in this species is narrower, about twice as wide as long, and much more feebly excavate behind than in *bifibulus* and the sixth abdominal segment with its lateral posterior angles more nearly form a right angle. The teeth along the lateral margins of the pronotum are more evident and usually black. The humeral angles are variable. There is little or no evidence of a transverse pale streak on the pronotum. *E. pustulatus* P. B. and *obscurus* (male) Pal. Beauv. are synonyms. It appears to be a rare insect in Cuba, as it is represented by only one specimen in the material before us.

Euschistus bifibulus (Palisot de Beauvois)

Plate XXV, Fig. 3

1805. Palisot de Beauvois, Ins. Afr. Amer. 148; Pl. X, Fig. 5.

Santiago de las Vegas on Egg Plant and *Solanum torvum* (Cardín, Hutson, Houser, and Bruner); Hoyo Colorado (Enamorado and Bruner); Punta Brava-Havana Prov., Viñales and Sierra Rangel, Pinar del Rio Prov. (Bruner and Acuña); Palmira, Santa Clara

Prov. (Ballou); Camagüey, Camagüey Prov. (Acuña); Seboruco (Bruner); Nagua (Ballou and Bruner) in Oriente Prov.—Est. Exp. Agron.

The male of this common species is easily differentiated from *crenator* (Fab.) by the hypopygium being decidedly wider than long, broadly and deeply excavate behind; sixth abdominal segment with the posterior lateral angles acutely spinose; female with the seventh abdominal segment extended in acutely spinose projections; humeral angles generally produced, acute or spinose; pronotum with a more or less evident pale impunctate streak running across the pronotum between the humeral angles; teeth along the lateral margin finer and in most cases pale. The size varies from 8–11 mm. Gundlach records this as *Euschistus bifibulus,* No. 341, in his collection.

Euschistus obscurus (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. 149; Pl. 10, Fig. 9 (♀ only).

1907. *Euschistus ursus* Van Duzee, Bull. Buffalo Soc. Nat. Sci. VIII: 8.

1926. *Euschistus bifibulus* Blatchley (nec Pal. B.), Heteropt. E. No. Amer. 140.

1927. *Euscristus atromaculosus* Barber, Bull. Bklyn. Ent. Soc. XXII: 241.

Camagüey, Camagüey Prov. (Acuña)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Described from San Domingo. Van Duzee described it as *ursus* from Jamaica and Haiti. Under the latter name Heidemann records it from the Isle of Pines. *E. atromaculosus* was described from Florida. Guérin recorded it from Cuba as *obscurus* and Gundlach as *crenator.* The anterior face of the pronotum is heavily infuscated, with a distinct, transverse, pale streak between the humeri; the corium has a number of scattered small black spots which are quite characteristic of the species and readily distinguish it from *crenator* or *bifibulus.*

Euschistus crassus Dallas

1851. Dallas, List Hem. I: 205.

Santiago de las Vegas, Havana Prov. (Otero); El Cobre and Omaja, Oriente Prov. (Bruner); Sto. Tomás, Península de Zapata, Santa Clara Prov. (Bruner)—Est. Exp. Agron. 12½ k. south of Pinar del Rio and 7 k. north of Viñales—A. M. N. H.

Although all of the specimens before us are considerably smaller (7–8 mm.) than specimens from Florida, which will run 10–11.5

mm. long, we can find no structural differences to warrant its description as new. It is very convex below with the short humeral spines directed somewhat obliquely forward; a more or less evident calloused pale line runs across the disk between the humeral angles.

KEY TO CUBAN SPECIES OF EUSCHISTUS

1. Male hypopygium with posterior margin (ventral view) broadly and deeply excavate; posterior apical angle of sixth abdominal segment acutely spinose; apical angles of the seventh segment in female attenuate, acute; a more or less evident pale streak across the pronotum between the humeral angles -------------------------------- *bifibulus* (Pal. B.)

   Male hypopygium either subtruncate posteriorly or feebly excavate or lightly lobate in the center -- 2

2. Male hypopygium with posterior margin nearly truncate and with a slight median lobe; body beneath strongly convex, ferruginous punctate; scutellum rather broad at apex ---------------------------- *crassus* Dall.

   Male hypopygium feebly excavate posteriorly; body moderately convex beneath with concolorous punctures; scutellum narrow at apex ------------ 3

3. Posterior lateral angles of the sixth abdominal segment in the male and seventh in the female produced, spinose; humeri strongly spinose. A few marks in front and an irregular line across the posterior disk black ---- --- *acuminatus* Walker.

   Posterior lateral angles of the sixth segment in the male acute, not produced or spinose ; pronotum without black fascia -------------------------- 4

4. Male hypopygium with lateral margins converging posteriorly; median posterior sinus more obvious; posterior margin of seventh abdominal segment of female obliquely truncate, apical angles not attenuated or produced; pronotum without pale transverse fascia between the humeral angles; scutellum and corium with scattered white spots -------- *crenator* (Fab.).

   Male hypopygium with lateral margins symmetrically rounded, not converging posteriorly; posterior angles of seventh abdominal segment of female acuminate and produced; a pale streak across the posterior disk of the pronotum; corium with scattered black spots -------- *obscurus* (Pal. B.).

Proxys punctulatus (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. 188; Pl. XI. Fig 9.

Santiago de las Vegas, Havana Prov. (Barreto and Bruner); Camagüey, Camagüey Prov. (Acuña), Taco Taco (Bruner, Acuña, and Ballou); Nagua, Oriente Prov. (Bruner and Ballou); Isle of Pines (Ballou)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Baraguá (Scaramuzza)—U. S. N. M.

This widely distributed species is readily distinguished from the other members of the genus by having the apices of all femora as well as the bases and apices of all tibiae black.

Thyanta perditor (Fabricius)

Plate XXV, Fig. 4

1794. Fabricius, Ent. Syst. IV: 102.

Viñales, Pinar del Rio Prov. (Bruner and Acuña): Santiago de las Vegas (Acuña) and Playa de Marianao (Bruner) Havana Prov.; Palmira, Santa Clara Prov. (Ballou); El Cobre, Oriente Prov. (Bruner); Camagüey, Camagüey Prov. (Acuña); Isle of Pines (Bruner)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Cayamas (Schwarz): "Cuba" (Uhler coll.)—U. S. N. M.

This is the largest and commonest species of the genus occurring in the West Indies, 10–13 mm. long, usually with a distinct purplish band across the pronotum between the humeri and two small black spots on the anterior face. The humeral angles are drawn out into acute spines directed somewhat anteriorly; lateral margins concavely arcuate to the apices of the spines. Posterior and anterior angles of each connexival incisure with a minute black spot.

Thyanta cubensis new species

Plate XXV, Figs. 4 and 5

Green with the narrow lateral margin of the pronotum yellow; narrow lateral margin of connexivum orange with a minute, black spot at the outer apical angle of segments 2–5, these more distinct below. Antennae with first two and base of third segments pale green, the remainder infuscated.

Head about one-sixth wider than long, in general shape and character of punctation not differing from *perditor*. Second segment of antennae slightly shorter than third. Apex of rostrum reaching to the middle of the second ventral abdominal segment. Pronotum two and two-thirds wider than long; lateral margin irregularly serrate, straight from anterior angle to near base of humeral spine whence it turns rather more abruptly than in *perditor* to form the front face of the spine; the latter more slender and directed more anteriorly than in *perditor;* the two black spots in the cicatrices of the anterior disk and transverse purple fascia between humeral angles lacking; posterior disk behind the cicatrices closely punctate between transverse irregular ridges, giving a more characteristic rugose appearance to that part than in *perditor*. Scutellum slightly longer than wide, distinctly rugulose anteriorly and closely punctate between the rugae. Hemielytra closely and evenly punctate, punctures coarser and shallower than on scutellum, with scattered pale calloused spots. Membrane clear and often faintly spotted. Venter rather closely punctate on the sides, nearly smooth, very sparsely punctate in the center; outer apical angle of sixth segment in the male more obtuse angled than in *perditor*, apical angles of the connexival segments tipped with black; sinus of the male hypopygium narrower, with the cleft in the central lobe much shorter than the lateral rounded lobes. Length 7–9 mm.

Type, male: Camagüey, July 20, 1923 (J. Acuña)—U. S. N. M. *Paratypes, males:* 5 Camagüey, July 20, 30, 31, 1923 (J. Acuña);

1 Isle of Pines, Feb. 1923 (C. H. Ballou); 1 Sta. Bárbara, Isle of Pines, Mch. 15, 1923 (S. C. Bruner); 1 Colonia, Cayo Romona, Sta. Clara Prov. (S. C. Bruner)—Est. Exp. Agron. 2 Cayamas (E. A. Schwarz); 1 "Cuba" (Uhler coll.)—U. S. N. M. 1 Zaza d. Media, Sept. 30, 1913; 1 Santiago, Oct. 2–10, 1913 (F. E. Lutz)—A. M. N. H. *Paratypes, females:* 3 Camagüey, July 21 & 30, 1923 (J. Acuña)—Est. Exp. Agron. 1 Cayamas (E. A. Schwarz)—U. S. N. M. 1 Zaza d. Media, Sept. 30, 1913 (F. E. Lutz)—A. M. N. H. Cat. No. 44045, U. S. N. M.

Very closely related to *perditor* from which it can be distinguished, aside from its smaller size, by the narrower pronotum with its straight lateral margin; more slender and more anteriorly directed humeral spines; and absence of black anterior discal spots and transverse purple-red band of the pronotum. While *perditor* has a minute black spot at the base and apex of each connexival segment, there is in this species but a single spot at each apical angle.

Thyanta casta Stal

1862. Stal, Stett. Ent. Zeit. XXIII: 104.

Jarahueca, Oriente Prov. (Bruner)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Compared to the other West Indian species this is more depressed; humeral angles of pronotum somewhat prominent and forming nearly a right angle; the lateral margins straight; second segment of antennae subequal to or slightly longer than the third; pronotum and base of scutellum transversely rugose; corium less distinctly and more shallowly punctate than in *custator*. The size varies from 8 to 9 mm. long.

Thyanta antiguensis (Westwood)

1837. Westwood, Hope Cat. 1: 36.

Santiago de las Vegas (Cardín, Hutson, Houser, and Acuña) and Playa de Marianao (Bruner) Havana Prov.; Baraguá (Stahl and Bruner) and Camagüey (Acuña) Camagüey Prov.—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

A common species throughout the West Indies. It is much smaller than the two previous species with the humeral angles not at all prominent and usually bluntly rounded; most commonly with a transverse purplish-red band between the humeri, although sometimes entirely green; second segment of the antennae generally longer than the third; apical angles of the connexival segments black; posterior mar-

gin of the male hypopygium broadly excavated (ventral view), without a median lobe.

Thyanta rugulosa (Say)

1831. Say, New Harm. Ind.; Compl. Writ. I: 319 (1859).

Stal and Uhler record this species from Cuba but we have not seen it from that island. This is one of the smaller species, scarcely larger than *antiguensis* (Westw.), measuring 5–7 mm. long. It has no purplish-red band between the humeri and the odoriferous canal is short, much shorter than the distance from its apex to the lateral margins of the metapleurum; the posterior margin of the male hypopygium is not lobate but lightly notched in the center.

KEY TO CUBAN SPECIES OF THYANTA

1. Humeral angles of pronotum acute, spinose; male hypopygium with a central lobe, cleft in the center ---------- 2
   Humeral angles not spinose; male hypopygium without central lobe ---------- 3
2. Lateral margins of pronotum straight, without either black discal spots or transverse purple-red band; connexival incisures with minute black spot at apical angles of segments only ---------- *cubensis* n. sp.
   Lateral margins of pronotum concavely arcuate from anterior margin to apex of spine; anterior disk with two small black spots and usually a transverse purple-red band between the humeri; connexival incisures with two minute black spots ---------- *perditor* (Fab.).
3. Second and third segments of antenna either nearly equal or second segment shorter than third; body more depressed; subshining; humeri usually angled. Species at least 8 mm. long = ? *maculatus* (Fab.)* ---------- *casta* Stal.
   Second segment of antenna distinctly longer than third; body not depressed; humeral angles not prominent, rounded. Small species 6–7 mm. long ---------- 4
4. Canal from odoriferous orifice shorter than the distance from its apex to the lateral margin of the pleurum; posterior margin of the male hypopygium with a small notch in the center ---------- *rugulosa* (Say).
   Canal from odoriferous orifice distinctly longer than the distance from its apex to the lateral margin of the pleurum; posterior margin of the male hypopygium entire ---------- *antiguensis* (Westw.).

Loxa pallida Van Duzee (?)

1909. Van Duzee, Bull. Buff. Soc. Nat. Sci. IX: 156

Santiago de las Vegas (Barreto and Acuña); La Lisa, Havana (Bruner)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

This was described from Jamaica: Horvath records it also from

* We have not been able to find any structural differences between *Thyanta maculata* Fab. and *T. casta* Stal and suspect that the latter is an unmarked form of *maculata*, in which case Fabricius' name would take precedence. Typically colored specimens of *T. maculata* (Teste Stal, Hem. Fab. I, 29, 1868) have the apical parts of the terminal three antennal segments, tylus, lateral angles and two spots on posterior disk of pronotum, and apex of scutellum fuscosubsanguineous. Specimens of both the marked and unmarked forms have been collected at El Cano, by S. C. Bruner and A. Otero.

Cuba. We have five specimens of what we take to be this species from Cuba and one from Jamaica. It is rather closely related to the species *flavicollis* as described and depicted by Drury but not that of Horvath 1925. Besides being smaller and relatively narrower, the lateral margins of the head are nearly straight and the longitudinal ridges fairly distinct. The antennae are pale, unicolorous, with the second and third segments nearly equal or the second a little shorter than the third. In two of the specimens the small white calloused spots are quite distinct on the surface of the pronotum, scutellum, and corium. The apex of the rostrum reaches the middle of the second ventral segment of the abdomen.

Loxa planifrons new species

Plate XXV, Figs. 6 and 7

Color yellow-green with punctures mostly concolorous; narrow lateral edge of head, pronotum, marginal teeth, humeral spines, and costal margins at base yellowish; connexivum and venter yellowish-green; antennae, rostrum, and legs pale yellowish-white; membrane vitreous, faintly speckled with green.

Head with lateral margins straight; juga acuminate, almost contiguous before apex of tylus, devoid of longitudinal rugae and punctures; transverse rugae fairly distinct. Antennae with basal segment rather short, not reaching to apex of head, second and third segments nearly equal. Rostrum with the apex reaching to the middle of the third ventral segment of the abdomen. Pronotum with the surface behind cicatrices densely covered with distinct, short, irregular rugae; obsoletely and finely punctate between the rugae, punctures often concolorous; lateral margin gently concavely arcuate from anterior margin to apex of humeral spine; margin armed with 15–17 short, blunt teeth; submargin without a broad band of distinctly colored punctures, so characteristic of most of the species, surface rugose to base of teeth; humeral spines slightly turned upwards, relatively short, subequal to or a little shorter than the distance between the eyes. Scutellum not strongly elevated on the basal disk, which is distinctly rugose, laterally and apically rather sparsely punctate. Hemielytra finely, concolorously punctate, more closely punctate towards outer apical angles. Connexivum coarsely, concolorously punctate. Opaque area of the metapleurum non-punctate, distinctly rugose. Venter very sparsely long pilose, smooth in the center, either side of which the surface is distinctly rugose and finely wrinkled; submargins obsoletely punctate. Sixth ventral segment of the male in the mid-line about twice as long as the three preceding segments combined (50:23); spines at the outer apical angles of fifth segment slender, acute, and extending to or beyond the posterior margin of the hypopygium. Length 19 mm.; humeral diameter 13 mm.

Type, male: Santiago de las Vegas, Cuba, Sept. 5, 1923 (J. Acuña)—Est. Exp. Agron. *Paratype, male:* 1 Santurce, Puerto Rico, Aug. 1, 1925 (Cooley and Gay)—U. S. N. M. *Paratypes, females:* 1 Santiago de las Vegas, Cuba, Sept. 2, 1923 (J. Acuña)—Est. Exp. Agron. 1 Pt. Cangrejos, Puerto Rico, Feb. 22, 1922 (G. N. Wolcott); 1 Santurce, Puerto Rico, Aug. 1, 1925 (Cooley and Gay)—

U. S. N. M. 1 Mameyes, Puerto Rico, Feb. 17, 1925 (L. B. Woodruff) —A. M. N. H. Cat. No. 44046, U. S. N. M.

This species may be readily distinguished by the absence of the longitudinal ridges on the head and by the distinct rugosity of the venter.

Murgantia histrionica (Hahn)

1834. Hahn, Wanz. Ins. II: 116; Fig. 196.

Almendares River, Havana Prov., 1917 (Cardín) on *Cleome pentaphylla;* Marianao and Vibora (Boucié)—Est. Exp. Agron. Havana (Knab and Morrison)—U. S. N. M.

The destructive harlequin cabbage bug seems to be well established in Cuba, at least about Havana. So far as our records go it has not hitherto been reported from the island.

Arocera protea var. **affinis** Distant

1880. Distant, Biol. Cent. Amer. Rhynch. I: 73; Tab. VII, Fig. 19.

Mountains near Taco Taco (Bruner, Acuña, and Ballou) and Sierra Rangel, Pinar del Rio Prov. (Brother Roberto)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

These correspond exactly with Distant's description and figure. A character not mentioned by the author is the fuliginous color of the membrane with its apical margin broadly pale. This species was recorded by Gundlach from Mte. Líbano, Oriente Province. The two specimens in the National Museum were wrongly determined by Uhler as *Runibia proxima* Dallas.

Runibia proxima (Dallas)

1851. Dallas, List Hem. I: 255.

Although we have not seen this from Cuba, Gundlach records it from both the eastern and western part of the island. A specimen from Jamaica is in the National Museum collection. It is much larger than the preceding, bright red, closely and finely punctate, with two black spots on pronotum, scutellum, and corium; apical angles of connexival segments distinctly produced and marked with black. Membrane black, margined with white.

Vulsirea violacea (Fabricius)

1803. Fabricius, Syst. Rhyng. 167.

Nueva Gerona, Isle of Pines (Ballou)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M. Gundlach records it from Matanzas and Santa Clara Province (Cienfuegos). A number of color varieties are

recognized. It is about the size of the preceding (14–16 mm.), mostly dark purple in color, with a broad red band, notched behind, across the disk of pronotum, a Y-shaped red mark on the scutellum and the connexivum banded with red and black. Apical angles of the connexival segments scarcely produced.

Nezara viridula (Linnaeus)

1758. Linnaeus, Syst. Nat. 444.

Santiago de las Vegas, Havana Prov. (Gómez de la Maza, Houser, Barreto, and Bruner); Camagüey, Camagüey Prov. (Acuña); Maisí (Acuña) and Nagua, Oriente Prov. (Bruner and Ballou); Viñales, Pinar del Río Prov. (Acuña)—Est. Exp. Agron. Soledad (Myers and Salt); Mina Carlota, Trinidad Mts. (Myers)—M. C. Z. Santiago de las Vegas (Cardín)—U. S. N. M.

A widely distributed species throughout most of the warmer parts of the world and quite common in the West Indies where, as elsewhere, it is of considerable economic importance. It can be distinguished from the following species by the character of the male hypopygium which in this species has a wide deep sinus, obtusely rounded in the center between the rounded lateral lobes and by the very short odoriferous canal.

Acrosternum marginatum (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. 147; Pl. X, Fig. 1.

Santiago de las Vegas (Hutson) and Punta Brava (Acuña) in Havana Prov.; Camagüey, Camagüey Prov. (Acuña); Santiago de Cuba, Oriente Prov. (Silvestri and Bruner); Viñales (Acuña) and Caibaguan, Sierre Rangel, (Acuña and Bruner) Pinar del Río Prov. —Est. Exp. Agron. Santiago de las Vegas (Cardín)—U. S. N. M.

The male hypopygium has a wide shallow sinus obtusely angled between the obtusely angulated lateral lobes. The margins of head, pronotum, corium anteriorly, and connexivum are orange yellow. The latter has a minute black spot at the apices of the segments which is also found in the preceding species.

Nezara nitida (Westwood)?

1837. Westwood, Hope Cat. I: 33.

1836. *Pentatoma marginale* Herrich-Schaeffer, Wanz. Ins. III: 96, Fig. 320 (Preocc.).

Recorded from Brazil and Argentine. A single specimen, No. 63, in the Gundlach collection is labeled "*Nezara marginale* H. S." It agrees with Herrich-Schaeffer's description and figure with the ex-

ception of the head which is pale (faded?). It is about the size of small specimens of *Acrosternum marginata* P. B. but is somewhat narrower with less prominent lateral angles of pronotum, and the head is shorter and broader. As to color, it is dark greenish, with a broad pale pinkish border around the body, narrower on costal margin of hemielytra and broader in front on the pronotum; a broad similarly colored median vitta runs from the anterior border of the thorax to the apex of the scutellum; the head is pale. We have followed Gundlach's determination of this specimen with considerable doubt, but owing to the fact that the collection is contained in a sealed glass-topped box it is impossible to remove it for close study. Possibly the specimen is not from Cuba, although Gundlach lists the species in his manuscript notebook as represented in both his collection and that of Felipe Poey, but does not indicate the locality from which it was obtained as was his custom.

Banasa subrufescens (Walker)

1867. Walker, Cat. Hem. Het. II: 290.

1872. *Banasa variáns* Stal, Enum. Hem. II: 43.

1851. ? *Rhaphigaster antica* Dallas, List Hem. I: 283.

Soledad and Mina Carlota, Trinidad Mts. (Myers)—M. C. Z. "Cuba" (Uhler coll.)—U. S. N. M. Fermina, Matanzas Prov. (Gundlach coll.).

The Cuban specimens answer perfectly to Stal's original description of *dimidiatus* from Brazil, which later, owing to the preoccupation of the name, he changed to *varians*. Distant, in Biologia Centrali Americana, figures *varians* and places two of Walker's species as synonyms, extending its range to Panama, Guatemala, Mexico, and the West Indies. Kirkaldy in his catalogue of 1909 places these several names as synonyms of *subrufescens* Walker as it antedates Stal's name. It seems to the authors that *Rhaphigaster antica* Dallas 1851 may very well be the same species, in which case it would take precedence over Walker's name. It bears a rather close superficial resemblance to *dimidiata* Say, but it is less convex both dorsally and ventrally, with a shorter and more narrowly rounded head in front as well as less disparity in the length of the second and third segments of the antennae.

Banasa punctatissima new species

Plate XXV, Fig. 8

Not highly polished but somewhat shining; rather closely punctate. Color above green with lateral margins of pronotum narrowly yellow; costal margin

of hemielytra anteriorly narrowly whitish; beneath yellowish; legs and antennae pale green with apical half of third and all of fourth and fifth segments of the latter darker.

Head short, about one-sixth wider than long; lateral margins strongly, concavely arcuate before eyes; evenly rounded in front with the three lobes equal; surface roughly, coarsely, but rather sparingly punctate; lateral lobes plainly wrinkled transversely. Antennae with third segment two-fifths longer than second and equal to fourth; fifth segment only a little longer. Rostrum extending to the hind coxae. Pronotum two and one-half times wider than long (13: 5), rather closely and evenly punctate; anterior submargin not depressed and provided with two or three irregular rows of punctures; lateral margin straight, smooth, calloused, scarcely reflexed; humeral angles somewhat projected, rounded. Scutellum unicolorous, about as long as wide, somewhat more sparingly punctate than the pronotum except at apex. Hemielytra rather coarsely but sparingly and evenly punctate. Membrane hyaline. Connexival margins pale green, a very slight, almost obsolete fuscous spot at the outer apical angle of each segment. Venter roughly, coarsely, and rather sparsely punctate on the sides. The male hypopygium, seen from below, is cut out in a very deep V-shaped sinus, rounded at base; the much depressed central portion occupying the base of the sinus gently rounded posteriorly; lateral angles on either side of the sinus obtusely rounded and densely setose there and along the inner margins of the sinus. Length 9.5 mm.

Type, male: Sto. Tomás, Península de Zapata, May 5–9, 1927 (Bruner and Acuña)—Est. Exp. Agron. *Paratypes, males:* Two with same data as type; Hoyo Colorado, Havana Prov. Oct. 7, 1926. *Paratypes, females:* Two with same data as type—Est. Exp. Agron. Cat. No. 44047, U. S. N. M.

This species is most closely related to *lenticularis* Uhler but is readily distinguished from that species besides its color by the much denser punctation on the dorsal parts. The genital segment (hypopygium) of the male is sometimes infuscated.

Pallantia macula (Dallas)

1851. Dallas, List Hem. I: 284.

Hoyo Colorado, Havana Prov. (Bruner); El Cobre, Oriente Prov. (Bruner)—Est. Exp. Agron. Cayamas (Schwarz)—U. S. N. M.

This is the first report of this species from Cuba. Stal lists it from Brazil and Mexico. Distant in figuring the species in the Biologia adds Guatemala. It has much the appearance of a *Banasa* but its short head and sulcate tibia will differentiate it.

Piezodorus guildinii (Westwood)

1837. Westwood, Hope Cat. I: 31.

Santiago de las Vegas, Havana Prov. (Acuña); Viñales, Pinar del Río Prov. (Bruner and Acuña); Nagua (Bruner and Ballou)

and El Cobre (Bruner) Oriente Prov.—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

A common species throughout the West Indies and most of the Neotropical regions.

Piezodorus tinctus Distant

1890. Distant, Biol. Cent. Amer. Rhynch. I: 341; Tab. 31, Fig. 22.

Camagüey, Camagüey Prov. (Acuña); El Cano and Playade Baracoa, Havana Prov. (Bruner); Viñales, Pinar del Río Prov. on *Pithecolobium arboreum* Linn. (Bruner)—Est. Exp. Agron. Cayamas (Schwarz)—U. S. N. M.

Distant described this from Panama and "Antilles." In the National Museum collection is a specimen from San Jacinto, Salvador. It is a broader form than the preceding species with a longer head and a much longer ventral spine which is projected forward to the middle of the mesosternum; the latter is longitudinally sulcate, not carinate; the apical angles of the connexival segments are more acutely prominent and the spiracles are not black-rimmed.

Modicia sexlineata Stal

1872. Stal, Enum. Hem. II: 46.

Sierra Maestra Mts. and Nagua, Oriente Prov. (Bruner and Ballou); Sierra Rangel, Pinar del Río Prov. (Bruner, Acuña, and Ballou)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Described from Cuba and apparently confined to that island. It has much the appearance of a *Podisus* and was erroneously labeled *Podisus politus* Uhl. (MS. name), while the above name was wrongly applied to *Pallantia macula* in the Gundlach collection. It is ochraceous, closely punctate with ferruginous, the punctures arranged in short, irregular, transverse rows on the pronotum and in six longitudinal rows on the head; the humeral angles are produced and subacute; the ventral spine is quite long and stout. The posterior femora of the male are distinctly incrassate and provided behind with a row of stout spines.

Arvelius albopunctatus (Degeer)

1773. Degeer, Mem. III: 331; Pl. 34, Fig. 6.

Santiago de las Vegas, Havana Prov. and Taco Taco, Pinar del Río (Bruner and Ballou); Herradura, Pinar del Río (Horne); Santo Tomás; Península de Zapata, Santa Clara Prov. (Bruner and Acuña)—Est. Exp. Agron. Upper Yara Valley (Scaramuzza); "Cuba" (Uhler coll.)—U. S. N. M.

A widely distributed species through the West Indies, Neotropical

regions, and southern part of the United States. Its pale, slightly green color, scattered white pustules of the corium, acutely pointed juga, and humeral angles, the latter turned somewhat anteriorly, will serve to distinguish this species.

Pharnus inconspicuus Herrich-Schaeffer

1840. Herrich-Schaeffer, Wanz. Ins. V: 102, Fig. 553.

Camagüey (Acuña)—Est. Exp. Agron.

Three specimens, two males and a female from the above locality are quite distinct from *insulicola*. The humeral angle is produced into a narrowly rounded lobe much more projecting than in that species and the lateral posterior angles of the connexival segments are more produced; the rostrum is much shorter, usually reaching only to the middle of the venter.

Pharnus insulicola Kirkaldy

1857. *Pentatoma (Mecistorhinus) variegata* Guérin, La Sagra Hist. de Cuba, Ins. 366 (Preocc.).

1909. *Pharmus insulicola* Kirkaldy, Cat. Cim. I: 151 (new name).

Camagüey (Acuña); Omaja, Oriente Prov. (Bruner)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. "Cuba" (Uhler coll.)—U. S. N. M.

This is a relatively narrower species in which the humeral angles are scarcely prominent; lateral margins of pronotum more nearly straight; rostrum reaching nearly to the end of the abdomen, and apical angles of the connexival segments not projected.

Neopharnus fimbriatus Van Duzee

1910. Van Duzee, Trans. Amer. Ent. Soc. XXXVI: 73.

Nagua, Oriente (Bruner and Ballou)—Est. Exp. Agron.

Described from Florida. The single male specimen we determined with some doubt. It has a very strong resemblance to *Pharnus inconspicuus* but the presence of a few prominent marginal spines or teeth on the pronotum and its more evident pilosity differentiate it.

Praepharnus new genus

Body depressed. Head wider than long; apices of the juga obtuse, a little longer than tylus and nearly contiguous before it; lateral margins concave a short distance before eyes; ocelli much more remote from each other than from the eyes; bucculae anteriorly forming a right angle, gradually evanescent posteriorly, not reaching beyond anterior margin of eyes. Antennae with basal segment just reaching to apex of head; second segment one-third shorter than third. Rostrum long and slender, its apex reaching to or slightly behind the posterior margin of the metasternal plate; basal segment extending beyond the

bucculae and reaching base of head; second segment a little longer than basal; third segment longest of all, one-third longer than second; fourth segment less than one-half the length of third. Pronotum over twice as wide as long; humeral angles strongly projected, forming nearly a right angle but narrowly rounded at apices; lateral margins carinate. Mesosternum broadly swollen, smooth, longitudinally carinate, carina gradually expanding anteriorly and there more elevated, extending slightly beyond anterior margin of mesosternum. Metasternal plate short and wide; anterior horns short and subacute, extending anteriorly but a short distance on the mesosternum; anterior sinus between the horns very obtusely angled; sinus at posterior margin broadly rounded; two posterior horns quite as long as anterior horns, their apices narrowly rounded. Groove from the odoriferous orifice long, acuminate, acute, much longer than the distance from its apex to the lateral margin of the metapleurum, not terminating in a long tapering ridge. Scutellum much longer than wide, apically somewhat narrowed. Hemielytra strongly punctate; frena extending well beyond middle of scutellum. Membrane provided with seven or eight simple veins which are not complete to posterior margin. Apical angles of connexival segments slightly prominent. Venter armed in front (second segment) with a flattened tubercle bluntly rounded anteriorly and fitting into the posterior sinus of the metasternal plate; a broad, bluntly rounded keel through the center. Tibia sulcate.

Type: Praepharnus prominulus n. sp.

More closely related to the genus *Pharnus* than to *Edessa* because of the presence of the mesosternal carina, shape of the metasternal plate, long, slender rostrum, as well as the depressed form of the body. From *Pharnus* it differs by having the second segment of antennae relatively longer, third segment of rostrum much longer than second, straight lateral margins of pronotum, etc.

Praepharnus prominulus new species

Plate XXV, Fig. 9 Plate XXVI Figs. 10 and 11

Head, pronotum, scutellum, and ventral parts olive green, in part coarsely punctate with black; small, smooth area between eyes and ocelli pale yellow-green; ocelli red; narrow lateral margins of pronotum yellow; hemielytra yellow-testaceous, heavily fusco-punctate; base and apical angles of connexical segments 2–6 black; mesosternal carina and metasternal plate pale yellow-white; venter with a few regularly arranged black spots; antennae pale; legs testaceous, paler towards base; femora preapically marked or punctate with fuscous; tibiae with a prebasal and preapical fuscous band. Head one-sixth wider than long (6: 5); lateral lobes (juga) bluntly rounded in front, projecting but little before apex of tylus but not contiguous before it; lateral margins suddenly contracted a short distance before eyes, thence nearly parallel, symmetrically rounded at anterior third; surface sparsely and irregularly punctate with black; ocelli red; a smooth paler area between eyes and ocelli. Bucculae higher in front, forming a right angle, gradually diminishing posteriorly and disappearing on a line with anterior margin of eyes. Antennae (last segment missing) pale, finely pilose, basal segment just reaching apex of head; second segment one-third shorter than third which in turn is about one-third shorter than fourth. Rostrum with the first and second segments more incrassate, subequal; third segment

one-third longer than second and fully twice as long as fourth. Pronotum about three times as wide as long; lateral margins straight, entire, impressed or carinate, and sparsely punctate with black; humeral angles somewhat projecting, nearly forming a right angle but narrowly rounded at apices; lightly concave behind humeri; dorsal surface coarsely and rather closely punctate with fuscous, except anteriorly and along submargins; with an obsolete median longitudinal carina; cicatrices somewhat elevated and provided with a few punctures. Scutellum but little longer than wide (25: 21); apex narrowly rounded; sparsely, irregularly, and coarsely punctate with black; a fuscous spot midway on either side of middle. Hemielytra more closely and finely punctate than scutellum; subcostal region nearly one-half as wide as corium. Membrane fuliginous, provided with three or four elongate, clear spaces between the simple veins which do not attain the margin. Segments of the connexivum coarsely and closely punctate anteriorly and posteriorly, depressed in the middle; apical angles slightly projecting. Meso- and metapleura as well as the venter almost impunctate but provided with a few small black spots. Elevated part of the mesosternum smooth, bounded on each side by a calloused, yellow, arcuate fascia; longitudinally carinate, carina highest and widest in front, projecting a little between the anterior coxae. Metasternal plate as described in the diagnosis of the genus. Groove from the odoriferous orifice long, open for its entire length, three times as long as the distance from its apex to the lateral margin of the metapleurum. Venter on each side provided with three rows of small black spots, one near each spiracle, obliquely back of these midway in the segments is the middle row, the inner or third row consisting of four spots, each situated on the incisures between segments 3–6; longitudinal carina wide, rounded and slightly elevated. Length 11–14 mm.; humeral diameter 7–7.5 mm.

Type, male: Camagüey, July 23, 1923 (J. Acuña)—Est. Exp. Agron. *Paratypes, females:* 1 Camagüey, July 21, 1923 (J. Acuña)—Est. Exp. Agron.; 1 North of Viñales, Sept. 16–22, 1913 (F. E. Lutz)—A. M. N. H. Cat. No. 44048, U. S. N. M.

Edessa (Aceratodes) cornuta Burmeister

1835. Burmeister, Handb. II: 356.

1894. *Edessa bifida* Uhler, Proc. Zool. Soc. Lond. 176 (nec Say).

Sierra Rangel (Acuña and Bruner) and Taco Taco (Bruner, Acuña, and Ballou), Pinar del Rio Prov.; Camagüey, Camagüey Prov. (Acuña); Nagua, Oriente Prov. (Bruner and Ballou; Sto. Tomás, Península de Zapata, Santa Clara Prov. (Bruner and Acuña); Sta. Fe, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. Guanajay (Palmer and Riley)—U. S. N. M.

We have followed Stal and Distant in the above determination of this species which is separable from *E. bifida* Say only by comparative differences. In the National Museum collection are deposited four specimens from the Biologia Centrali Americana series labeled *cornuta* Burm. by Distant, also many other specimens of the same thing from Mexico, Central America, and several islands in the

West Indies. As compared to *bifida,* the body is somewhat narrower posteriorly, the pronotum less convex, and viewed from the side the declivous front is less nearly vertical, the dorsal surface more profusely punctate, and the scutellum apically wider.

Edessa (Aceratodes) cubana new species

Plate XXVI, Fig. 12

Very closely related to *E. chelonia* Van Duzee. Head, pronotum, entire scutellum, outer area of the corium, and connexivum faded green; narrow lateral margins of head and pronotum and subcostal nerve yellow; inner field of the hemielytra castaneous, with irregular yellow markings, more linearly arranged at the other limits of the clavus; body beneath yellow-green, mesosternum beneath the front of the sternal process with a rather large reddish spot; antennae and legs pale, first three segments of the former minutely spotted with fuscous, terminal segment black; legs minutely spotted with fuscous.

Head one-third wider than long; lateral lobes finely and sparsely punctate; vertex somewhat elevated, faintly, transversely wrinkled. Second segment of antenna subequal to or a little shorter than third. Bucculae about four times as long as wide, evenly elevated throughout, rounded anteriorly and posteriorly. Rostrum with second segment a little longer than third and fourth together; apex confined in the anterior notch of the metasternal plate. Pronotum over two and one-half times wider than long (19: 7); lateral margins narrowly impressed, straight, and forming a right angle with the humeri, which project very slightly beyond the margin of the corium; surface evenly and closely punctate and somewhat rugose on the anterior disk posteriorly to the smooth cicatrices; anterior submargin somewhat depressed in the middle. Scutellum about one-fifth longer than wide; the more depressed, flattened apical part gradually contracted to a rather narrowly rounded concolorous apex; disk coarsely and sparsely punctate; apically more closely and finely punctate. Hemielytra within the subcostal nerve closely punctate with castaneous, leaving a linear calloused yellow area on either side of the claval suture and a few scattered smooth calloused spots on the disk of corium; subcostal area much narrower than in *chelonia* Van D., closely and confluently punctate, except near base. Membrane fuliginous. Connexival segments coarsely and somewhat sparingly punctate. Canal or groove from the odoriferous orifice ending in a long tapering ridge which is plainly longer than the distance from its apex to lateral margin of pleurum. Metasternal plate with the anterior horns wider than the diameter of the rostrum, lightly divaricate, their apices rounded and reaching to the middle of the mesosternum; posterior horns short, acute. Venter yellow, mottled and spotted with green, coarsely and rugosely puntate on the sides; the broad, central, rounded ridge smooth and impunctate. Hypopygium of the male with the posterior margin deeply and widely sinuate; apex of sinus narrowly rounded; lateral lobes obtusely rounded. Length 14 mm.; humeral diameter 7.5 mm.

Type, male: Palma Mocha Mt., Sierra Maestra (alt. 1070–1350 meters), July 10–20, 1922 (C. H. Ballou and S. C. Bruner)—Est. Exp. Agron. *Paratypes, females:* 1 Cangrejeras, Havana, May 30, 1931 (S. C. Bruner)—Est. Exp. Agron.; 1 "Cuba" (C. G. Aguayo) —Univ. Nacional. Cat. No. 44049, U. S. N. M.

Very closely related to *chelonia* Van Duzee, a paratype of which from Jamaica is in the National Museum. *E. cubana* can be distinguished from *chelonia* by the more strongly impressed lateral margins of the pronotum, much narrower subcostal region, and presence of a large red spot on the mesosternum.

Edessa (Aceratodes) excoriata new species

Plate XXVI, Fig. 13

Rather closely related to *flavoflua* n. sp. Head, pronotum, entire scutellum, broad margin of the corium, connexivum, and ventral parts olive green; lateral margin of pronotum pale yellow; inner field of the hemielytra castaneous, irrorate with yellowish markings; antennae pale testaceous; first two segments plainly, third faintly spotted with fuscous; fourth segment apically embrowned; fifth fuscous, pale at base. Legs pale testaceous with apical two-thirds of femora and tibiae heavily spotted with fuscous, less evident on the two posterior pairs; body beneath more yellow green with spiracles white-rimmed; membrane fuliginous; acute apical angles of the connexival segments black.

Head short and wide, more than one-third wider than long, impunctate, transversely wrinkled, broadly rounded in front; vertex somewhat elevated; ocelli red. Antenna with second segment a little longer than third. Bucculae rather low, nearly four times as long as wide, a little higher in front, the lower edge somewhat sinuous, gradually disappearing posteriorly. Pronotum over twice as wide as long (5: 2); lateral margins straight, calloused, impressed anteriorly before middle; anterior submargin lightly impressed; obsoletely carinate down the middle; surface shallowly, sparingly punctate; anteriorly with wide rounded irregular rugae separating the punctures; cicatrices smooth, elevated, limited posteriorly by a strongly impressed line; humeral angles bluntly rounded, not projecting beyond the costal margins. Scutellum one-sixth longer than wide, flattened, somewhat impressed apical part tapering to a narrowly rounded, concolorous apex; more sparsely punctate on the elevated basal disk. Hemielytra with the clavus and mesocorium castaneous, with small scattered yellow areas; subcostal area about one-third as wide as the widest part of mesocorium; closely punctate. Connexivum broadly exposed, closely punctate; apical angles of segments slightly and acutely produced. Groove or canal from the odoriferous orifice ending in a tapering ridge, the apex of which is distant from the pleural margin for about the length of the ridge. Metasternal plate with anterior horns about as wide as diameter of rostrum, subacute, lightly divaricate. Sides of venter sparsely, coarsely punctate and rugose. Posterior margin of male hypopygium rather shallowly notched in the center. Length 11–13 mm.; humeral diameter 5.5–6.5 mm.

Type, male: Baracoa, Oriente, Aug. 21–30, 1929 (S. C. Bruner and L. Bouclé). *Paratypes, males:* 1 with same data as type; 2 Camagüey, July 15 and 23, 1923 (J. Acuña)—Est. Exp. Agron. 1 Port-au-Prince, Haiti, May, 1925 (G. N. Wolcott)—U. S. N. M. *Paratypes, females:* 3 same data as type, Est. Exp. Agron. 1 Port-au-Prince, Haiti, May, 1925 (G. N. Wolcott)—U. S. N. M. Cat. No. 44050, U. S. N. M.

Under the manuscript name *Edessa excoriata* Uhler, Gundlach records this species from Cárdenas, Matanzas Province, and Bayamo, Oriente Province. It is somewhat smaller than the preceding and similarly colored but is more nearly related to *E. flavoflua*. Besides its difference in color, the scutellum is not pale at apex, head more broadly rounded anteriorly, lateral margins less strongly impressed, humeral angles scarcely protruding, rostrum shorter, etc.

Edessa (Aceratodes) flavoflua new species

Plate XXVI, Fig. 14

Related to *excoriata* n. sp. Head, pronotum, scutellum except at apex, and connexivum pale green intermixed with yellow; narrow lateral margin and median carina of pronotum and apex of scutellum pale yellow; inner field of hemielytra testaceous; subcostal region and clavus pale yellow, coarsely punctate with fuscous.

Antennae, legs, and venter yellow testaceous. Head one-fifth wider than long; margins before sinus not parallel but gently converging to the rather narrowly rounded apex; lateral lobes strongly punctate, rugose; a smooth area at inner margin of eyes; vertex somewhat elevated, almost smooth. Second segment of antenna subequal to or a little shorter than third. Bucculae high, about twice as long as the greatest height, lower front margin rounded, broadest before middle, thence gradually diminishing posteriorly. Apex of rostrum reaching behind the anterior notch of the metasternal plate; second segment a little longer than third and fourth together. Pronotum about two and one-half times as wide as long (17: 7); lateral margin straight, with calloused yellow spots and a few fuscous punctures on extreme edge; submargins impressed and strongly, transversely rugose; anterior submargin strongly and widely depressed, coarsely punctate; a more or less evident calloused carina runs through the middle; each cicatrix occupied by a small punctate elevation; anterior disk posterior to the cicatrices strongly and transversely rugose, punctate between the rugae, giving a rough appearance to the pronotum; posterior disk sparsely and somewhat coarsely punctate; humeral angles obtusely rounded, slightly projecting beyond the costal margin. Scutellum but little longer than wide (13: 11); anterior elevated disk coarsely and sparingly punctate, the narrower apical portion more finely and closely punctate. Hemielytra with the clavus for the most part smooth, provided with a few scattered, fuscous punctures; inner field of the corium (mesocorium) most finely punctate except at apex where it is more coarsely punctate; narrow subcostal region sparsely and coarsely punctate with fuscous. Connexivum coarsely and sparsely punctate, with a pale yellow tubercle in the middle of segments 2–6; lateral apical angles of segments very slightly projecting. Membrane clear, hyaline. Groove from odoriferous orifice not terminating in a long tapering ridge; the distance from apex of groove to lateral margin of pleurum twice as long as length of groove. Anterior horns of metasternal plate rather strongly divaricate, each about the diameter of rostrum. Venter sparsely, shallowly punctate on the sides, strongly rugose; each spiracle on segments 2–6 followed by a small calloused tubercle. Posterior margin of male hypopygium lightly and broadly notched in the center; lateral lobes broad, scarcely projecting beyond apex of notch. Length 12.5–13.5 mm.; humeral diameter 7 mm.

Type, male: Viñales, Apr. 6–9, 1922 (S. C. Bruner and J. Acuña). *Paratypes, males:* 1 Soledad, Nov. 6, 1915 (P. Cardin)—Est. Exp. Agron. 1 "Cuba" (Uhler collection) labeled *Aceratodes meditabunda* Fab.—U. S. N. M. *Paratypes, females:* 2 Viñales, April 6–9, 1922 (S. C. Bruner and J. Acuña); 2 Sierra Rangel, Aug. 28, 1929 (J. Acuña and S. C. Bruner), Jan. 27–30, 1931 (J. Acuña and A. Otero) —Est. Exp. Agron. 1 "Cuba" (Uhler coll.)—U. S. N. M. Cat. No. 44051. U. S. N. M.

This is the species which both Uhler and Gundlach misidentified as *meditabunda* Fab., and this accounts for the fact that Uhler redescribed the true Fabrician species as *rugulosa*. The roughly sculptured pronotum, more pallid corium, less pointed pale apex of scutellum, and longer rostrum will distinguish this species from *meditabunda*.

Edessa (Aceratodes) chlorophyla new species

Figs. XXVI, Figs. 15 and 16

Body more elongate than in the other species here described. Color olive green, speckled or irrorate with yellow; beneath paler green intermixed with much yellow; legs and antennae testaceous, first three segments of the latter minutely speckled with fuscous; last two segments embrowned.

Head one-sixth wider than long (6: 5); lateral margin without a very distinct sinus before the eyes, almost straight, tapering to a narrowly rounded apex; surface impunctate; lateral lobes finely, obliquely wrinkled, vertex strongly elevated. Antenna with second segment subequal to third (♀). Bucculae evenly elevated throughout, the lower margins straight. Rostrum with apex reaching a little beyond apex of notch in the metasternal plate; second segment as long as third and fourth united. Pronotum well over twice as wide as long (19: 8); lateral margins straight, calloused, yellowish, not impressed or carinate; humeral angles slightly projecting, forming an obtuse angle; anterior submargin not strongly depressed; a median longitudinal carina more or less distinct, more evident anteriorly; anterior disk rugose, finely punctate between the yellowish rugae; posterior disk less distinctly rugose, with punctures closer set; transverse oval cicatrices very distinctly limited by depressed lines the smooth impunctate area within quite strongly elevated. Scutellum much longer than wide (16: 11), apical part rather narrowly contracted, with almost parallel sides; apex rounded, concolorous; disk of basal half sparsely, coarsely punctate; laterally and apically more finely and closely punctate. Hemielytra with the clavus sparsely punctated; one complete row of punctures just within the claval suture; corium closely and coarsely punctate; subcostal region narrow, about one-fourth as wide as mesocorium, more sparsely punctate. Membrane fuliginous. Connexivum green, very faintly and sparsely punctate; acuminate apical angles of segments quite prominent; apical angles of the seventh segment and all of the genital sclerites quite acutely extended posteriorly, visible from above (♀). Groove from the odoriferous orifice terminating in a long, acutely tapering ridge which is much longer than the distance between its apex and the metapleural margin. Two anterior horns of the metasternal plate long, much flattened dorso-ventrally, very

wide and lobate, three times as wide as second segment of rostrum. Venter on either side of the middle impunctate, irregularly rugose; the rugae yellowish; the broad longitudinal carina very distinctly elevated. Length 14.5 mm.; humeral diameter 7 mm.

Type, female: Taco Taco, April 1–6, 1922 (S. C. Bruner, J. Acuña, and C. H. Ballou)—Est. Exp. Agron. Cat. No. 44052, U. S. N. M.

The more elongate body, differently shaped head, and broad, flattened, anterior horns of the metasternal plate, as well as the color, will distinguish this very distinct species from the other Cuban species of *Edessa* here described.

KEY TO CUBAN SPECIES OF EDESSA

1. Apex of scutellum plainly marked with pale yellow ---------- 2
   Apex of scutellum concolorous ---------- 4
2. Promotum distinctly rugose, carinate in middle, submargins strongly impressed ---------- *flavoflua* n. sp.
   Pronotum neither rugose nor longitudinally carinate, margins not impressed 3
3. Pronotum more convex, sparsely punctate; apex of scutellum broader ---------- *bifida* Say.
   Pronotum less convex, less sparingly punctate; apex of scutellum narrower ---------- *cornuta* Burm.
4. Color of corium green, concolorous with pronotum and scutellum; lateral margins of head nearly straight; anterior horns of metasternal plate long and flattened; ridge terminating odoriferous orifice much longer than the distance from its apex to metapleural margin ---------- *chlorophyla* n. sp.
   Color of corium in part castaneous, variegated with yellow; lateral margins of head strongly convex sinuate; anterior horns of mesosternal plate compressed ---------- 5
5. Apex of scutellum subacute; mesosternum distinctly carinate; groove from odoriferous orifice long, terminating in a very short, ill defined ridge. Much shorter than the distance from its apex to the metapleural margin; bucculae disappearing before base of head ---------- *meditabunda* Fab.
   Apex of scutellum narrowly rounded; mesosternum not at all or less distinctly carinate; groove from odoriferous orifice short, terminating in a distinct, more or less elongate ridge; bucculae variable ---------- 6
6. Groove from odoriferous orifice and terminal ridge short, both together not longer than the distance from apex to the metapleural margin; venter very distinctly rugose, impunctate; first two segments of antenna and legs spotted with fuscous ---------- *excoriata* n. sp.
   Groove from odoriferous orifice and terminal ridge both together longer than the distance from apex to the metapleural margin; venter distinctly punctate ---------- 7
7. Subcostal region of corium one-half as wide as mesocorium; spiracles marked with a distinct dark green spot; mesosternum yellowish ---------- *chelonia* Van D.
   Subcostal region of corium narrow, not more than one-fourth as wide as mesocorium; spiracles concolorous; mesosternum with a large reddish spot ---------- *cubana* n. sp.

Subfamily ASOPINAE

KEY TO CUBAN GENERA OF SUBFAMILY ASOPINAE

1. Frena extended to middle point of scutellum. Apical half of scutellum broad, but narrower than diameter of corium. Anterior tibia either dilated or simple. Ventral spine of abdomen long, produced nearly to intermediate coxae. At least fifth ventral segment and part of sixth on each side of the disk furnished with a patch of silky hairs in the male. Humeral angles most commonly not prominent--------------*Oplomus* Spin.

   Frena distinctly extended beyond middle point of scutellum. Scutellum contracted apically behind middle, much narrower than corium. Ventral spine of abdomen variable. Humeral angles most commonly produced, often spinose or sometimes bifid at apex------------------------------ 2

2. Second visible ventral segment of abdomen provided with a low, scarcely produced tubercle, somewhat conical anteriorly. Preapical spine of fore femora commonly obsolete. Pronotum transversely and scutellum apically calloused. Male with patches of silky hairs on segments 3–6---*Andrallus* Bergr.

   Second visible ventral segment armed either with an evident broad, elevated, flattened process or with a distinctly produced spine. Male without ventral silky patches on the abdomen------------------------------------ 3

3. Anterior femora armed beneath with a distinct, stout, preapical spine. Bucculae strongly elevated, lower margins rounded. Second ventral segment of abdomen armed with a distinctly elevated flattened process, blunt or rounded anteriorly. Large species---------------*Alcaeorrhynchus* Bergr.

   Anterior femora devoid of a preapical spine. Bucculae lightly elevated. Second visible ventral segment of abdomen armed with an anteriorly projected spine. Smaller species------------------------*Podisus* H. S.

Oplomus annotatus Uhler

1863. Uhler, Proc. Ent. Soc. Philad. 362.

Casa Villate, Havana (Cevera) — Est. Exp. Agron. "Cuba" (From Professor Poey in the Uhler coll.—U. S. N. M. Type No. 43581).

Rather closely related to *O. tripustulatus* Fab. and marked much as in some of the varieties of that species. It is, however, less polished, much more densely and coarsely punctate; the lateral margins of the pronotum are nearly straight and scarcely impressed. It is apparently a rare species.

Andrallus spinidens (Fabricius)

1787. Fabricius, Mant. Ins. II: 285.

Viñales, Pinar del Rio (Brother Roberto); Palmira, Santa Clara Prov. (Ballou)—Est. Exp. Agron. "Cuba" (Uhler coll.) U. S. N. M.

A widely distributed species, recorded from Madagascar, Asia Minor, India, Austro-Malayan Region, Polynesia, Mexico, and Louis-

iana. There are specimens in the National Museum collection from St. Domingo and Costa Rica. It has much the appearance of a large *Podisus* but there is no long spine on the second segment of the abdomen. The humeral angles are provided with a bifid process. the anterior spine of which is the longest; the pronotum is transversely and the scutellum longitudinally callously carinate; the legs are unarmed, with the tibiae strongly grooved. Gundlach records this as *Mutyca limbata* Uhler, a manuscript name, from Cárdenas, Matanzas Prov. and Fermina, probably in Santa Clara Province.

Alcaeorrhynchus phymatophorus (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer 112; Pl. 8, Fig. 2.

Las Animas, Sierra Rangel, Pinar del Rio Prov. (Bruner and Acuña)—Est. Exp. Agron. "Cuba" as *Canthecona grandis* Dallas (Uhler coll.)—U. S. N. M.

Distant in Biologia Centrali Americana has given some characters for differentiating this species from *grandis*. Another feature of *phymatophorus* not mentioned by Distant is the more profuse punctation of the sides of the venter.

Podisus mucronatus Uhler

1897. Uhler, Trans. Maryland Acad. Sci. I: 386.

Santiago de las Vegas, Havana Prov. (Bruner); Palmira, Santa Clara Prov. (Ballou); Omaja, Oriente Prov. (Bruner); Camagüey (Acuña); Holguin (Bruner)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Described by Uhler from Cuba and Florida. It is pale yellow, largely ferruginous above and rather closely and coarsely punctate; humeral angles armed with rather long, anteriorly directed spines; lateral margins of pronotum straight to base of spines, broadly calloused, yellow, irregularly toothed; ventral spine of abdomen rather long, extending forward to anterior margin of posterior coxae. This is represented by an unnamed specimen in the Gundlach collection numbered 159.

Podisus gundlachi (Guérin)

1857. Guérin—La Sagra, Hist. Cuba—Ins. 367; Pl. 13, Fig. 2.

Camagüey (Acuña)—Est. Exp. Agron. Cayamas (Schwarz); "Cuba" (Uhler coll.)—U. S. N. M.

A Cuban species recorded by Gundlach from Zarabanda, Fermina, and Yateras in Matanzas and Oriente Provinces. It is a little smaller than *mucronatus*. The humeral angles are greatly produced, bifid,

and turned so that the secondary subapical tooth lies directly below the main upwardly inclined tooth. A darker band runs across the pronotum between the lateral processes. The first antennal segment is extremely short, the second segment almost twice as long as third. The ventral spine of abdomen is very short.

Podisus sagitta (Fabricius)

1794. Fabricius, Ent. Syst. IV: 99.

Los Animas, Sierra Rangel and Viñales, Pinar del Río Prov. (Bruner and Acuña); Santiago de las Vegas (Hutson, Acuña, and Bruner) and Hoyo Colorado (Enamorado and Bruner), Havana Prov.; Camagüey, Camagüey Prov. (Acuña)—Est. Exp. Agron. Soledad (Myers)—M. C. Z. Cayamas (Schwarz); Upper Yara Valley and Baraguá (Scaramuzza); "Cuba" (Uhler coll.)—U. S. N. M.

Very closely related to the Mexican *fuscescens* Dallas from which it differs as follows: anterior prong of humeral bifid process not turned anteriorly: scutellum longer than wide; pronotum and hemielytra relatively wider.

Podisus acutissimus Stal

1870. Stal, Enum. Hem. I: 53.

Santiago de las Vegas (Acuña and Otero).

Three specimens show the usual variation in the character of the humeral processes and the amount of melanism on the posterior lobe of the pronotum. Professor Uhler in his article on the Hemiptera Heteroptera of Grenada records the above species from St. George as *P. gaumeri* Dist. and specimens so labeled are in the National Museum. They represent merely a pale variety of Stal's species. *Podisus cloelia* Stal, a closely related species, was listed from Cuba by Gundlach. The specimen in his cabinet so labeled does not agree with Stal's description nor with Distant's figure of the species and probably represents a form distinct from any here considered.

Podisus subferrugineus new species
Plate XXVI, Fig. 17

Stramineous, for the most part closely and finely punctate with ferruginous; antero-lateral margins of pronotum, margin of apex of scutellum, legs, and ventral parts pale yellow, the latter rather closely punctate with ferruginous; humeral spines and posterior disk of corium ferruginous-red; membrane hyaline, with a longitudinal median fuscous stripe.

Head with tylus equal to juga; the latter not contiguous at apices; lateral margins subparallel, lightly converging anteriorly; apex rounded; surface of

lateral lobes closely, vertex more sparsely punctate. Antenna ferrugino-testaceous; second segment twice as long as third, which in turn is about one-third shorter than fourth which is one-fourth longer than fifth. Rostrum reaching to just beyond posterior coxae; second segment one-third longer than third. Pronotum finely and closely punctate with ferruginous, more sparsely so across central disk; an obsolete pale longitudinal line down the middle faintly continued through the scutellum; lateral margins pale, calloused to the base of humeral spines, provided with five or six irregular obtuse serrations; humeri drawn out into very prominent acute ferruginous spines, directed outwardly and slightly upward. Pleura sparingly punctate with ferruginous. Legs pale, apices of tibiae and tarsi suffused with fuscous. Scutellum longer than wide (8: 7), depressed across the middle, closely punctate with ferruginous; apical fourth much contracted, more sparsely punctate; apex semicircularly smooth, pale yellow. Corium closely punctate at base; posterior disk more sparingly punctate with ferruginous; subcostal region coarsely punctate. Membrane hyaline, with a wide, median, longitudinal, fuscous stripe. Connexivum narrowly exposed, ferruginous-red, not fasciate with black. Venter shining, stramineous, profusely punctate with rosy-red; a pale brownish spot anteriorly on segments 3–6 midway between center and lateral margins; ventral spine short, acute, not reaching to middle of posterior coxae; apical angles of sixth abdominal segment acute, prominent. Length 12 mm.; humeral diameter 7 mm.

Type, male: Palma Mocha, Mt. Sierra Maestra, July, 1922, elevation 1070–1350 meters (Bruner and Ballou); *Paratype, female:* same data—Est. Exp. Agron. Cat. No. 44053, U. S. N. M.

This species seems to be close to *P. congrex* Stal from Mexico and Central America but the scutellum in that species is not pale at apex. In the male, particularly, the margins of the abdomen are strongly converging posteriorly.

KEY TO CUBAN SPECIES OF PODISUS

1. Humeral angles of the pronotum bifid at apices 2
   Humeral angles armed with a simple spine 3
2. Two spines of humeral process in the same horizontal plane, posterior spine much the shorter; apex of scutellum not noticeably pale ....*sagitta* (Fab.)
   Spines of humeral process placed one above the other; apex of scutellum pale; disk of corium with a round black spot ....*gundlachi* (Guér.).
3. Membrane entirely fuliginous, non-vittate; humeral spines strongly turned anteriorly .... *mucronatus* Uhl.
   Membrane vittate with fuscous; humeral spines straight or slightly turned anteriorly 4
4. Scutellum with large smooth calloused areas in basal angles; pale yellowish or greenish species, marked with black and frequently red fascia; ventral spine of abdomen long .... *acutissimus* Stal.
   Scutellum obsoletely calloused at basal angles; ferruginous species with humeral spines directed outwardly; ventral spine short..*subferrugineus* n. sp.

Subfamily TESSARATOMINAE

Piezosternum subulatum (Thunberg)

1783. Thunberg, Nov. Ins. Sp. II: 41, Pl. 2, Fig. 55.

A rather common species in the Neotropical regions and recorded from Cuba by Stal. Listed by Guérin from Cuba and San Domingo as *Pentatoma (Edessa) vacca* Fab. In the Gundlach collection there are three specimens taken in the Sierra Rangel, Pinar del Río Province.

This is a large species, the female measuring at least 20 mm. in length. Color greenish, often fading to yellowish. Lateral angles of prothorax produced as rounded prominences; outer apical angles of abdominal segments produced into sharp narrow points, directed backwards, more prominent on posterior segments; apex of scutellum produced into a long acute angle and provided with a prominent median carina.

APPENDIX

Guérin La Sagra Hist. Cuba–Insects 1857	Dr. Pedro Valdés Ragués Classificación Gundlach Hemípteros Cubanos, etc 1910*	Our determination
...	Tetyra pinguis	Tetyra antillarum Kirkaldy
Scutellera (Augocoris) cretacea Voet	Augocaris 6– punctata	Augocoris illustris (Fabricius)
Scutellera (Augocoris) pallida Pal B.	...	Augocoris illustris (Fabricius)
Scutellera (Pachycoris) nitens Dallas	Pachycoris fabrici	Pachycoris fabricii (Linnaeus)
Scutellera (Pachycoris) boscii Fab	Diolchus Bosari	Diolcus boscii (Fabricius)
Scutellera (Pachycoris) irrorata Fab	Diolchus irroratus	Diolcus irroratus (Fabricius)
...	Diolchus variegatus	Diolcus variegatus Herrich-Schaeffer
Scutellera (Pachycoris) obliqua Guer	Mesotrypa sinuosa	Symphylus caribbeanus Kirkaldy
...	Sphyrocaris obliquus	Sphyrocoris obliquus (Germar)
Scutellera (Corimeloena) basalis Germ	...	Euryscytus guttiger (Stal)
...	Corimelena minuta.	Eucoria minuta (Uhler)
...	Corimelena incerta	Euryscytus incerta (Uhler)
...	Actas communis	Aethus communis Uhler
	Actas insularis [?]	Aethus indentatus (Uhler)
...	Stenocaris longulus [?]	...
...	Pangarus piciatus	Geocnethus cubensis n. sp
...	Amnestris pusillus [?]	Amnestus pusio Uhler
	Podops dubius.	Amaurochrous dubius (Palisot-Beauvois)
Pentatoma (Brochymena) poeyi Guér	Brochymena poeyi	Brochymena poeyi (Guérin)
Pentatoma (Mormidea) ypsilon Linn.	...	Solubea insularis (Stal)
Pentatoma (Mormidea) geographica Fab	...	Solubea insularis (Stal)
...	Mormidea albisignis	Mormidea albisignis Stal
...	Mormidea pectiventris	Mormidea pictiventris Stal
Pentatoma (Mormidea?) typhoeus Fab.	Oebalus pugnas	Solubea pugnax (Fabricius)
	Oebalus griseus	Solubea linki (Heidemann)
Pentatoma (Mormidea) pustulata Pal. B.	Euschistus crenator	Euschistus crenator (Fabricius)
...	Euschistus bifibulus	Euschistus bifibulus (Palisot-Beauvois)
...	Euschistus thorascicus	Euschistus acuminatus Walker
Pentatoma (Prooxys) punctulata Pal B.	Pronis punctulatus	Proxys punctulatus (Palisot-Beauvois)
Pentatoma (Mormidea) perditor Fab.	Thysanta perditor.	Thyanta perditor (Fabricius)
...	Thysanta taeniola..	Thyanta antiguensis (Westwood)
...	Thysanta rugulosa	...
...	Loxa Flaviclollis	Loxa sp.
...	Runibra proxima...	Runibia proxima (Dallas)
Pentatoma (Vulsirea) nigrorubra Spin	Vulsira violacea	Vulsirea violacea (Fabricius)
Pentatoma (Nezara) smaragdula Fab	Nezara viridula	Nezara viridula (Linnaeus)
Pentatoma (Nezara) marginata Pal.. B.	No. 66 Gundlach coll omitted	Acrosternum marginatum (Palisot-Beauvois)
...	Nezara marginale.	(?) Nezara nitida (Westwood)
...	Bonasa varians..	Banasa subrufescens (Walker)
...	Piezodanus Guidini	Piezodorus guildinii (Westwood)
...	Modicia 6 lineata ..	Pallantia macula (Dallas)
Pentatoma (Arvelius) albopunctatus DeG.	Arvelius albo-punctatus.	Arvelius albopunctatus (Degeer)
Pentatoma (Mecistorhinus) variegata	Pharus variegatus.	Pharnus insulicola Kirk
Pentatoma (Aceratodes) inconspicua. H. S.	...	Pharnus inconspicuus (Herrich-Schaeffer)
Pentatoma (Aceratodes) cornuta Burm.	Edessa bifida	Edessa cornuta Burmeister
Pentatoma (Aceratodes) meditabunda Fab.	Edessa meditabunda.	Edessa flavoflua n. sp.
...	Edessa scoriata.	Edessa excoriata n. sp.
...	Ophonus annulatus	Oplomus annotatus Uhler
Pentatoma (Canthecona) phymatoptera	Mutyca phymatophora	Alcaeorrhynchus phymatophorus (Palisot-Beauvois)
Pentatoma (Canthecona) gundlachii	Podysus Gundlachi.	Podisus gundlachi (Guérin)
...	Podysus sagitta.	Podisus sagitta (Fabricius)
...	Podysus doelina.....	Podisus sp.
...	Podisma pallidus.	Modicia sexlineata Stal
Pentatoma (Edessa) vacca Fab..	Rizostemum sublata	Piezosternum subulatum (Thunberg)

* Actual spelling of scientific names.

Explanation of Figures

PLATE XXV

Fig. 1. *Geocnethus reversus* n. sp.
Fig. 2. Genital segment of *Euschistus crenator* ♂
Fig. 3. Genital segment of *Euchistus bifibulus* ♂
Fig. 4. Pronotum of *Thyanta cubensis* n. sp. and *T. perditor.*
Fig. 5. Genital segment of *Thyanta cubensis* n. sp. ♂
Fig. 6. Genital segment of *Loxa planifrons* n. sp. ♂
Fig. 7. Genital segments of *Loxa planifrons* n. sp. ♀
Fig. 8. Genital segment of *Banasa punctatissima* n. sp. ♂
Fig. 9. Head, pronotum and scutellum of *Praepharnus prominulus* n. sp.

PLATE XXVI

Fig. 10. Genital segment of *Praepharnus prominulus* n. sp. ♂
Fig. 11. Genital segments of *Praepharnus prominulus* n. sp. ♀
Fig. 12. Genital segment of *Edessa cubana* n. sp. ♂
Fig. 13. Genital segment of *Edessa excoriata* n. sp. ♂
Fig. 14. Genital segment of *Edessa flavoflua* n. sp. ♂
Fig. 15. Head and pronutum of *Edessa chlorophyla* n. sp.
Fig. 16. Genital segments of *Edessa chlorophyla* n. sp. ♀
Fig. 17. *Podisus subferrugineus* n. sp.

PLATE XXIV

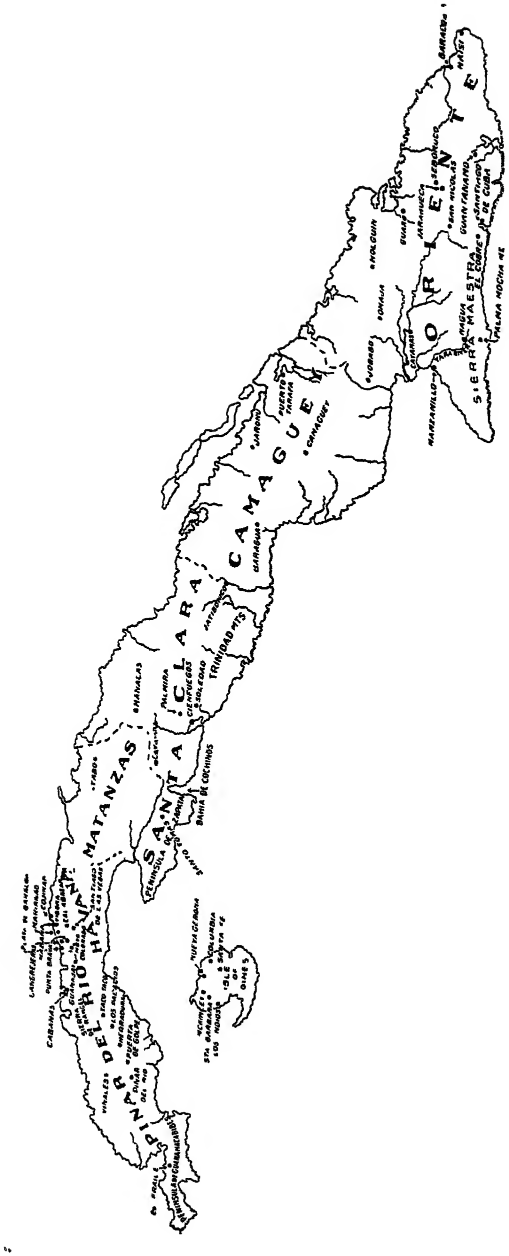


PLATE XXV

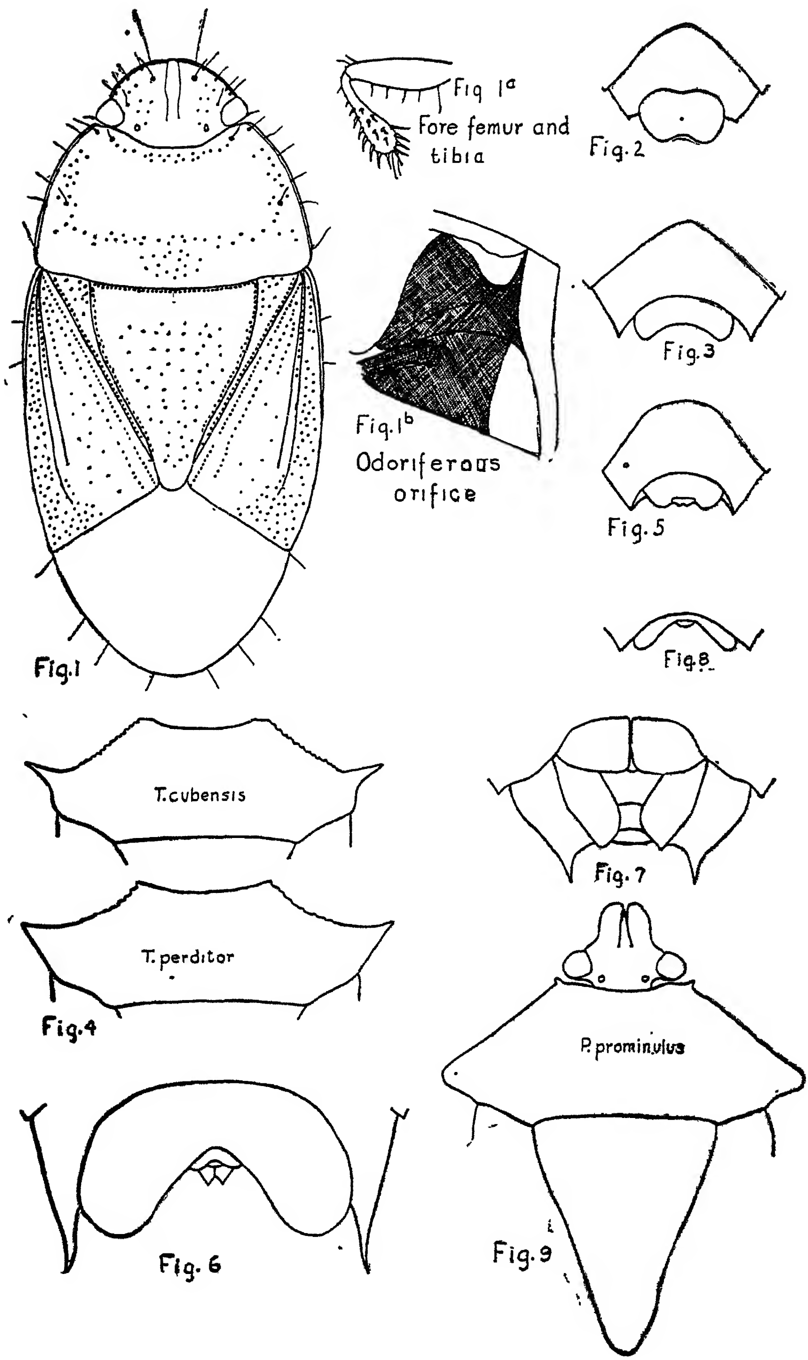


Fig 1ᵃ
Fore femur and tibia
Fig. 2
Fig. 1ᵇ
Odoriferous orifice
Fig. 3
Fig. 5
Fig. 1
Fig. 8
T. cubensis
T. perditor
Fig. 4
Fig. 7
P. prominulus
Fig. 6
Fig. 9

PLATE XXVI

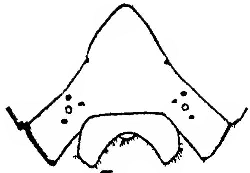


Fig. 10

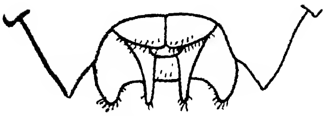


Fig. 11

Fig. 12

Fig. 13

Fig. 14

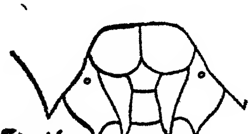


Fig. 16

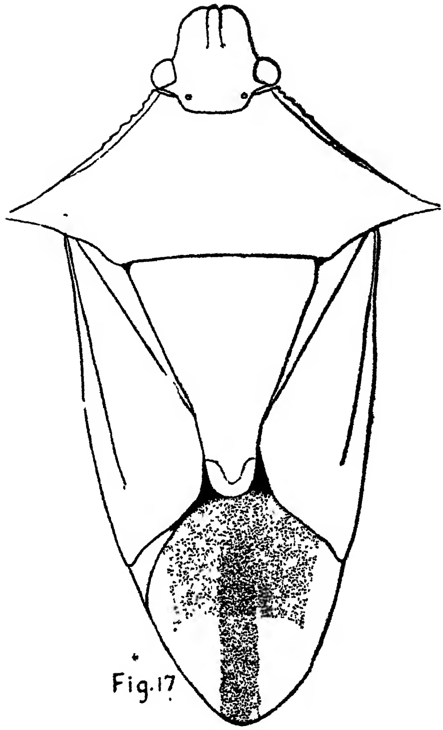


Fig. 17

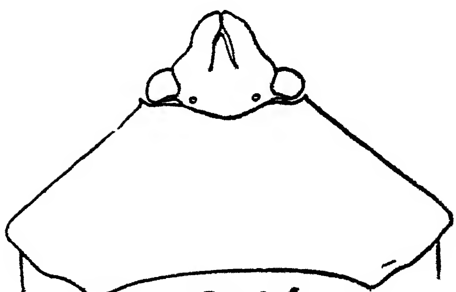


Fig. 15

INDEX TO GENERA AND SPECIES *

(Preoccupied names, synonyms, and doubtful species are in intalics.)

* NOTE: In this index are not included the species from other countries which were mentioned for comparative or other purposes in the text, and which have never been reported as occurring in Cuba.

THE DAMPING-OFF OF TOBACCO AND ITS CONTROL IN PUERTO RICO [1]

J. A. B. NOLLA [2]

In recent years there has been great alarm among the tobacco growers of Puerto Rico because of the spread of a persistent malady in our tobacco seed-beds, the damping-off disease. The studies begun six years ago are outlined and discussed in this paper. The chief aim has been to develop a practical working method for the control of this dreaded malady.

Damping-off is here treated chiefly in relation to tobacco (*Nicotiana tabacum L.*). We have shown that the pathogenes responsible for damping-off of tobacco may also produce a similar disease in some garden vegetable and castor bean seedlings.

NAMES

The most common name for the disease in Puerto Rico is "sancocho" or "salcocho." Recently, the names "salcocho blanco" (white damping-off) and "salcocho prieto" (black damping-off), have been introduced into the long list of popular agricultural names, to distinguish between what the growers regard as two forms of the disease.

HISTORY AND RANGE

Hesse's investigations in 1874 (16) mark the beginning of numerous researches on damping-off on many of the higher plants. Most of the literature on the subject, however, deals with the disease on suscepts other than tobacco. The disease probably occurred on tobacco as early as it did on the other suscepts. Breda de Haan (5) reported a seed-bed rot of tobacco from Sumatra and Java in 1896. Cook and Horne (9) reported damping-off from Cuba in 1905. The disease has subsequently been the subject of special studies there. Search among publications where tobacco in Puerto Rico is mentioned has shown that, apparently, the first report of the disease in that Island is by Loew (20) in 1908. To quote: "a peculiar disease, spreading from a center in ring-like progression, was observed in the

[1] A thesis presented to the Faculty of the Graduate School of Cornell University in partial fulfilment of the requirements for the degree of Doctor of Philosophy. Submitted for publication, May, 1932.

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tobacco seed-beds of Caguas. The circle of dead bleached seedlings increased continuously and could be checked only by removing the soil to some depth and treating the spot with diluted formaldehyde (1 spoonful to 30 gallons of water). The disease is called "sancochado" in Porto Rico."

It has been reported from various other parts of the world. In Puerto Rico it has been prevalent probably during the last three or four decades but its importance has been largely disregarded. Damping-off, in general, was briefly discussed by Johnson (19) in 1914, who placed special emphasis on the subject of the control in relation to tobacco.

This malady now occurs in both tropical and temperate zones but its severity is increased as tropical conditions are approached. In some countries soil sterilization is now a common practice and methods of culture are so advanced that the disease is rarely serious.

It is present in nearly all the tobacco soils of the true tobacco sections of Puerto Rico. One of the pathogenes, *Phytophthora Parasitica* * has not been found in the coastal section from Arecibo to Aguadilla where poorer, native types of tobacco are grown, but the other, *Pythium debaryanum,* is common. Here the temperature is relatively higher and the humidity lower than in higher elevations.

IMPORTANCE

The losses from damping-off fluctuate from year to year. In certain seasons when precipitation is moderate, the disease occurs only in localized areas in the seed-beds and may be easily kept in check. On the other hand, should heavy rains be prevalent throughout a season, the magnitude of the losses will be very great. During the season of 1927, heavy rains brought about a disastrous condition. Late plantings had to be made and there were not enough seedlings for a normal planting. In many instances the seedlings were completely swept away by the disease. Reports from various sections of the island and the author's own observations showed losses from 8 per cent to as high as 90 per cent. Data obtained from the agricultural agents on about 105 acres of cloth-shaded beds and 310 acres of open beds in 1927, showed a range of infection of from 8 to 80 per cent. If a curve were to be plotted with these data, the mean would be above 50 per cent and the mode would exceed that figure. In 1928 the losses were quite severe in some sections while in 1929 the season was especially unfavorable for the disease.

* Throughout this paper the designation *P. Parasitica* stands for *Phytophthora Parasitica* Dastur, var. *nicotianae* Tucker.

Under such circumstances tobacco planting, in certain years, is quite an uncertain proposition. Even when growers plant in advance to allow a wide margin for losses from damping-off, the extent of his planting remains uncertain until the seed-bed season is nearing the end. The disease may destroy the larger part of his seedlings and then he will be at the mercy of the other planters whose seedlings may be of undesirable varieties or of poor quality. If he succeeds in buying enough seedlings for his farm he will have to pay from $1 to $1.50 or even a higher rate per thousand plants. This makes planting more expensive by increasing the cost per unit of production. Another disadvantage which may occur is the introduction of "black shank," carried into his field on poorly selected seedlings from infested beds.

Symptomatology

The morphologic symptoms of tobacco damping-off appear in various manifestations depending on the age of the plants. Very young seedlings take on a dirty green color and die. The seedlings are so violently attacked that usually the time between the first symptoms and death is very short. On larger plants, which are not overcrowded and which have not developed a slender stem, if infected at the surface of the soil, the first symptoms consist of a wilting of the leaves. This is followed by a rapid blackening of the stem all the way up to the terminal bud. The stem tissues appear to shrink. These symptoms are usually produced by *Phytophthora Parasitica*, but may also be caused by *Pythium debaryanum*.* When plants are too crowded, their stems are rather long. Here the symptoms may be evident either as small, lens-shaped or elongated lesions which do not extend far up the stem or as large lesions in the cortical tissues, originating near the soil surface and spreading up and around the stem, in a good many cases girdling it completely. These lesions are usually pale and are typical of the disease caused by *Pythium debaryanum*. Such plants will generally have the lignified tissues unaffected and when transplanted into the field will send out roots above the lesions and usually develop into normal plants. *Phytophthora Parasitica* produces very similar symptoms (see plates XXVII, XXVIII and XXIX.) Occasionally lens-shaped lesions will be formed on the stems and adventitious roots develop. When transplanted into the field during a rainy period such plants rapidly succumb to the attacks of the invading fungus. The organism in the small lesion commences activity on reaching the new environment. Such a con-

* Since these two pathogenes produce damping-off effects almost identical on tobacco they are here discussed as producing one disease.

dition had been thought to be due to a cause different from that of the damping-off but it has been found that *P. Parasitica* is the responsible agent. Roots of young seedlings are not usually affected as the pathogenes seem to spread more readily over the surface of the soil and infect the stems at soil level. However, roots of the larger seedlings may furnish the point of invasion. This is especially true in the case of *Phytophthora Parasitica.*

The leaves are also a common point of entrance for the pathogenes. The symptoms here consist of circular to irregular light-brown spots with light centers. The plesionecrotic zone between the unaffected and necrotic tissues is pale green. The spots rapidly increase in size and involve the entire leaf blade, and in later stages extend to the stem where blackening and death of the tissues occur and ultimately the death of the plant.

The histologic symptoms consist, in the first place, of hydrosis of the tissues, especially when infection occurs in the leaves. The cells of the invaded tissues are soon killed by toxins or related products secreted by the penetrating hyphae, and the cell walls and cell contents are blackened presumably as a result of the reactions with the fungous secretions. Collapse of the cells is followed by the dissolution of the primary walls of the mesophyll cells of the leaf or of the cortex of the root, as the case may be. Withering of the affected individuals soon follows. The vascular tissues, especially in infections by *Phytophthora Parasitica* are also stained and killed. This results in the wilting of the above-ground parts.

Signs

Sporangia are produced abundantly in the soil by *Phytophthora Parasitica* and to a lesser extent by *Pythium debaryanum.* However, *Pythium debaryanum* forms oospores in the soil and in the tissues of the affected organs. Oospores of *Phytophthora Parasitica* have not been found in the tissues of diseased seedlings. Chlamydospores are formed in the infected parts when either of the two pathogenes is present.

Etiology

The pathogene *Pythium debaryanum* was discovered and described by Hesse in 1874. It was named in honor of the famous German mycologist, Anton de Bary. There is now a long list of publications on this fungus, in which it is recorded on a large number of suscepts.

The other pathogene, *Phytophthora Parasitica* var. *nicotianae* was first described as *P. nicotianae* by Breda de Haan in 1896 (5). This

fungus was first associated by its discoverer, with the cause of the "lanas" disease; and known in America as the black-shank. A serious seed-bed trouble was found to be caused by the same fungus in the Deli district of Sumatra and at Buitenzorg in Java.

Tisdale (27) first reported the black-shank organism from America in 1922 as causing a typical damping-off in young tobacco plants. Later, in 1923, he (28) gave *Phytophthora nicotianae* Breda de Haan as the cause of black-shank.

In Puerto Rico damping-off of tobacco is due to *Pythium debaryanum* and *Phytophthora Parasitica* var. *nicotianae*. Rhizoctonia has not been found in the tobacco seed-beds, but an examination of some plants received from the Cayey region in January, 1930, showed the presence of this fungus, and it might well be that the pathogene is spreading in that section. *Sclerotium Rolfsii* was isolated from yellowed seedlings but it does not seem to be able to cause much damage.

That the Phytophthora on tobacco in Puerto Rico is *P. nicotianae* was established in a previous paper by the author (23). The cultures used in this investigation were the same isolates studied in connection with the black-shank disease. Ashby (1) in 1928 proposed the name *Phytophthora Parasitica* Dastur for a combination of species among which is *P. nicotianae*. Obviously he ignored any suscept relationship. Tucker (29) who has been unable to separate *nicotianae* from *Parasitica* on a morphological basis, regarded the difference in pathogenicity between the two as not of specific significance and, therefore, designated the fungus *P. Parasitica* Dastur, var. *nicotianae* Tucker.

The omnivorous *Pythium* in Puerto Rico has been isolated from many suscepts. The isolates when compared with known cultures of *Pythium debaryanum* have shown only slight or no morphological differences.

PATHOGENICITY

The pathogenicity of our isolates of *Pythium debaryanum* and *Phytophthora Parasitica* was established by a series of experiments.

The following list of isolates used is given with their sources;

P 1. *Phytophthora Parasitica,* from a tobacco seed-bed in Cayey;

P 2. *Pythium debaryanum,* from a tobacco seed-bed in Caguas;

P 3. *Phytophthora Parasitica,* from a tobacco seed-bed in Cayey;

P 4 to P 14. *Phytophthora Parasitica,* tobacco black-shank Caguas;

P 16. *P. debaryanum,* tobacco plant with black-shank lesions, Cayey;

P 17. *P. Parasitica,* disease of young transplants; Cayey;

P 18. *Phytophthora* sp., tomato damping-off or bending-over, Río Piedras;

P 19. *Phytophthora* sp., eggplant fruit rot;

P 20. *Pythium debaryanum,* cucumber damping-off, Río Piedras;

P 216. *Phytophthora Parasitica,* obtained from Trucker who obtained it from Tisdale—the Florida black-shank fungus;

P 217. *Phytophthora* sp., obtained from Tucker but source unknown.

Not all of these isolates were used in all experiments because they were gradually accumulated during the course of the investigations.

The flats in which most of the pathogenicity experiments were conducted were prepared as follows: A wooden box 2 ft. × 2 ft. was filled with good compost. A frame about 2 ft. high was built around each box. Cell-o-glass was then fastened tightly to this frame, the lower edge extending about 2 in. below the upper edge of the sides of the box. This insured the contents against possible infestation from external sources. Frame-covers were also provided in order to prevent rain water from falling into the box.

As soon as the flats were filled with the soil compost, they were sterilized with a 1–50 formaldehyde solution, at the rate of 1 gal. per sq. ft. or 4 gal. to each flat. After the soil was well soaked with the solution it was covered with burlap for 48 hours.

A week after disinfestation, the soil was infested with cultures of the isolates to be tested. At the end of 7 days after infestation of the soil seed was sowed of the types "Borinquen" or Connecticut Round Tip (very susceptible to black-shank) and a native type called "País" (resistant to black-shank). The beds were heavily watered with boiled water every morning, until the experiment was completed.

Expt. 1: Twenty-four flats were used, three were left uninfested to be used as checks while the remaining 21 were infested on Dec. 22, 1926 as follows: A set of 3 flats with P 1, P 2, P 3, P 4, P 10, P 13, and P 14. These flats were sown on Dec. 29 as follows: 2 flats in each set with "Borinquen" seed the remaining flat with "País" seed. The check was similarly seeded.

The results observed at intervals of 2 days until Jan. 21, 1927 were as follows:

(*a*) There was an even germination on all the 24 beds.

(*b*) P 1 (*Phytophthora Parasitica*) produced a virulent infection on Jan. 10 and in 3 to 4 days had destroyed all the seedlings in the three flats alike.

(*c*) P 2 (*Pythium debaryanum*) showed infection on Jan. 10, and by Jan. 18th all the seedling in the three flats had been killed.

(*d*) P 3. The first symptoms were observed on Jan. 10. Later on Jan. 13 there were only a few plants standing.

(*e*) P 4 and P 10 showed the symptoms later than in the preceding three cases but by Jan. 21 nearly all the plants had been destroyed.

(*f*) P 13 and P 14 showed infection on Jan. 18 and by Jan. 21 there were only a few seedlings unaffected.

(*g*) No damping-off developed in the checks, the plantlets attaining a normal development.

There are two conclusions to be drawn from this experiment, namely, that both *Pythium debaryanum* and *Phytophthora Parasitica* cause severe damping-off of tobacco seedlings and that there is no difference in the resistance or susceptibility of the two varieties of tobacco used.

A second experiment was conducted in which infestation was made 16 days after germination and when seedlings were making a vigorous growth. Ten-day-old mass cultures of P 216, P 217, P 16, P 17, P 18, and P 20 on cotton-seed meal agar were employed.* The cultures were broken up into small fragments, poured into tin pans and water was added so as to obtain a good dilution. This was then sprinkled over the seedlings and washed into the soil with water from sprinkling cans.

A week after infestation symptoms of the disease had appeared in all of the infested flats except those with P 18 and P 217. Spots on leaves appeared only in the flats infested with P 17 and P 216.

From these results it may be concluded that, (1) the Florida black-shank pathogene *P. Parasitica* (P 216) causes typical damping-off; (2) the *Phytophthora* sp. (P 217) is non-pathogenic to tobacco seedlings; (3) two *Pythium* strains from tobacco (P 16) and cucumber (P 20) produce typical damping-off; *P. Parasitica* (P 17) from transplant tobacco causes typical damping-off, and (5) a *Phytophthora* sp. which causes bending-off in tomatoes does not cause the disease on tobacco.

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* Prepared by adding to 40 grams of cotton-seed meal, 4 grams of agar-agar and water enough to make the volume to 200 cc. in an Erlenmeyer flask, then heating in the autoclave at the usual temperature for sterilization.

Life History

An account of the life history of *Phytophthora Parasitica* has been given in another paper (23). In the account of the life history for *Pythium debaryanum* given below, it will be seen that it is similar to that of the former. The primary cycles are initiated on the seedlings by inoculum from the soil or from bits of diseased plants carried into a pathogene free seed-bed by agents of dissemination. The inoculum consists of mycelium from infested debris and of oospores, chlamydospores, conidia, and zoospores. Inoculation is effected by the growth of the inoculum to the susceptible part or by its transportation to the suscepts by agents of various kinds. Surface water currents, laborers, animals, and probably burrowing insects as well as other agents serve to disseminate it.

With favorable conditions of temperature and moisture, the oospores, and probably the chlamydospores may be assumed to germinate. Laboratory attempts to germinate the oospores and chlamydospores have been unsuccessful, an experience which confirms that of other writers. The germ tubes from the oospores must come into contact with the suscepts, or, failing to do so, they develop into a mycelium in the soil.

The mycelium under adequate temperature and humidity conditions assumes a very active role. Zoosporangia and conidia are developed at the end of special hyphae. The zoosporangia germinate in the water on the suscepts' surfaces or in pools, giving rise to zoospores. These and the conidia germinate by sending out a germ tube. The term conidium is used here in the sense of many authors for the sporangia which do not germinate by zoospores but by a germ tube. There seem to be no grounds for regarding these as distinct structures, both are, undoubtedly, genetically alike and the manner of germination may be, after all, influenced by external factors not yet well understood.

Germ tubes and the hyphal tips of the mycelium coming in contact with the susceptible surfaces penetrate the cell-walls of the tissues. Hawkins and Harvey (15) present evidence to show that the hyphae of *Pythium debaryanum* penetrate the cell-walls of the potato tuber by means of mechanical pressure. The germ tubes or hyphae may enter the plant through the stomata. Zoospores of *P. Parasitica* occasionally brought into contact with the leaf surface at the margin of the blade by splashing rain drops or other means, send their germ tubes into the tissues, in this manner giving rise to the characteristic spots. We have been unable to get infection of leaves with zoospores of *Pythium debaryanum*.

Once the hyphae or germ tubes find themselves inside the suscept tissues they begin to invade these. The mycelium becomes much branched and advances in all directions. The hyphal branches penetrate the cell-walls or may penetrate in an intercellular manner. The hyphae of *Pythium debaryanum* become constricted at the place where they pass through a cell-wall. However, this phenomenon has not been observed in *Phytophthora Parasitica*. It has been generally accepted that *Pythium debaryanum* secretes a substance which kills the cells of the suscepts in which it occurs.

During the course of the development of the pathogene on the tender stems and leaves of the tobacco seedlings zoosporangia and conidia are produced. These are more abundantly produced by *Phytophthora Parasitica* but on the other hand, *Pythium debaryanum* produces an abundance of oospores in the tissues and in the surrounding soil; while the former produces only a few. Chlamydospores are produced by both pathogenes. The sporangia germinate readily under favorable environmental conditions and their zoospores together with the germinating conidia (probably also chlamydospores and oospores) furnish the inoculum for the secondary cycles. The primary cycles end with the death of the seedlings. Only in a few cases, when affected plantlets have developed vigorously, does recovery from the disease occur, and then only when the pathogene involved is *Pythium debaryanum*. Seedlings at any age or period of development, when infected by *Phytophthora Parasitica* die. After the destruction of the plants in a bed or part of them, the land is usually left idle. The pathogenes now enter into a new phase of their life history. They are able to hibernate in the debris of the dead seedlings or in organic matter of any kind. Here they spend a saprophytic life awaiting the reappearance of any one of their suscepts.

Epiphytology

Environmental conditions seem to affect both pathogenes similarly. The amount of moisture in the soil seems to be the most important factor determining the spread and severity of these pathogenes. Under conditions of extreme humidity the disease plays havoc with seedlings. It is natural to expect this with pathogenes which have such life habits and characteristics. In sections where rainfall is slight there is seldom any fear of damping-off. Temperature variation is not an important factor in Puerto Rico since favorable temperatures prevail through the year. In our experiments, conducted at all seasons, temperature fluctuations have not appeared to influ-

ence the occurrence and spread of damping-off very much. Seed-beds shaded with cloth are usually more liable to suffer severely. In those where no shade has been used, the disease has been checked with less difficulty. That some beds of seedlings have been saved by removing the cloth and allowing the sun rays to penetrate directly to the surface, indicates that the reduction of the moisture on the surface of the soil and on the plants, removes the chances of spread and development. The elevation at which the seed-bed is located in Puerto Rico seems to have little influence on damping-off.

Damping-off is usually severe in beds which have been heavily fertilized with nitrogenous fertilizers. This is true of soils manured with the more soluble salts such as nitrate of soda, and beds periodically watered with solutions of the salt. But organic manures seem to afford the best conditions for its development. Fresh barnyard manure furnishes a good medium for the pathogenes already existing in the soil. Barnyard manure in Puerto Rico is worse than nothing in the preparation of seed-beds and its use should be discouraged. Fortunately, the average grower has learned this from experience and there is little likelihood of its being used to any great extent. However, when seed-beds are properly disinfested and well managed there will be little danger from organic matures.

Thick sowings are a constant danger in Puerto Rico. In spite of the fact that during the last two decades the growers have been advised by private parties or by government agents to make as light sowings as possible, the present day growers still insist in getting a very large number of plants per unit area. The experiences of the season of 1927 show this very plainly. We found cases of growers who had been managing tobacco seed-beds for the last ten or twelve years for a certain tobacco company, and had then used only about 2 pounds of seed to the acre. When they started in work of their own they made sowings at the rate of 4 pounds to the acre. The result was an overcrowding of seedlings in the seed-beds. With the coming of the rainy season, damping-off occurred and the destruction was almost complete. Experience in Puerto Rico shows that not more than 1.5 to 2 pounds of seed should be sown to an acre.

Control

Eradication

General Considerations and Miscellaneous Practices

The control of tobacco damping-off is at present one of the problems which the tobacco growers have to face. Practical treatment

for beds before or after the germination of the seed will be welcomed by the growers of tobacco in Puerto Rico.

The first known and most general treatment of the land for the control of plant diseases ever recorded for Puerto Rico is the destruction of the causal organism by fire. The first records of the use of this means for the cleaning or sanitation of soils intended for seed-beds are lost in the rather obscure history of Puerto Rican agriculture. The pioneer tobacco growers in the island did not know that plants would die from disease; when tobacco culture was first attempted their virgin lands probably were free from infestation. In some sections of the country the clearing of the land was followed by burning of the trash, shrubs, and trees. In other cases (especially recent ones, which the writer has seen), the beds were prepared in places where the plant "maya" (*Bromelia Pinguin*) had been growing for years. This large terrestrial bromeliaceous plant grows thickly in waste places and along fences and these seemed favorite places for tobacco beds. When set on fire these plants burn slowly since their leaves are more or less juicy. This slow burning develops an intense heat, which is maintained in the soil for a relatively long time. This may be an explanation for the small amount of damage produced by the so-called rot or damping-off in seed-beds prepared in such sites. Without knowing it these growers with their rude methods were preventing a serious trouble. Later as seed-beds had to be increased in extent the patches of "maya"-covered land had to be abandoned for other waste lands. In other sections this system was unknown, but instead grass was burned over the soil. Gradually with the clearing of land the amount of material to be burned on the soils intended for seed-beds decreased and the seed-beds received no treatment whatsoever. The disease called here "pudrición" (rot) or "salcocho" (damping-off) began to increase year after year until it is now widespread over the entire island. The method of firing as used by the first growers was an effective one under the conditions of slight infestation then prevailing. Its effectiveness decreased when beds were less frequently exposed to the action of the heat and when they received contamination from adjoining fields through surface drainage.

A second eradicatory measure, but a poor one, used by our growers has been the removal of the diseased seedlings from the fields as soon as the disease appears. This practice is effective in the control of some diseases and, most certainly, in those cases where the disease occurs in isolated individuals; but in the case of tobacco damping-off, especially in Puerto Rico, it is very dangerous. The

type of labor employed in this kind of work does not commend its use. A laborer who removes diseased seedlings will only serve to spread the inoculum over healthy beds. In the majority of instances the rotting plants have been scooped out and thrown into the ditches where they await the coming rains to wash them down to other ditches and into other beds. After seedlings have been removed it is the practice to dust the bare spots with slaked lime. This lime does not kill the fungus and observations show that even indirectly it will not check the spreak of the pathogenes. It is an unfortunate thing that methods like this should even be mentioned in the literature as effective. Bunker (4) says "The practice of scraping off the infected soil and applying lime is good." However, immediately after, he describes a method which is more satisfactory and which shows there was no need of approving the former. This latter method consists in spraying the infested areas well into the surrounding heathy plants with a 1–25 formaldehyde solution. After soaking with this solution the diseased plants may be removed from the beds. We are of the opinion that this is a good measure to follow. We have used a slightly lower concentration, a 1–30 solution, with equally good results. Once the infested spots have been thus drenched, the removal of the infected plants seems to us rather unnecessary. There is little likelihood that these will serve as sources of inocula. Recently we have succeeded in obtaining excellent results with a new copper preparation—a copper fluosilicate dust. This material has a very high content of copper in the soluble form. When applied to infested spots in tobacco beds it soon burns the foliage and stems. At the rate of about 8 grams to the square foot of surface it gives as good results as the 1–25 or 1–30 formaldehyde solution. It has the advantage over the latter in not having that penetrating, undesirable odor. Further, its action is longer continued than that of formaldehyde. It is a good plan to sprinkle the beds with water after dusting with copper fluosilicate dust. A 1–200 Uspulun solution at the rate of 1 gallon to the square foot of surface has also given satisfactory results but none of the treatments are as simple and effective as dusting with copper fluosilicate.[1]

Of historical interest is the case reported by Loew (20) of a certain Mr. DuBois who had introduced a new system for preventing the disease, by transplanting the young seedlings into a second seedbed before they were set in the field. It is of further interest to note that the writer observed exactly the same system employed by

[1] After this paper had been prepared the writer was informed that this compound will not be prepared any longer.

the farmers of Colombia, South America, in 1929. This is a rather primitive method which is inapplicable and uneconomical on a large scale.

Eradication of pathogenes by soil treatments before sowing the seed

Steaming of the soil

It is highly improbable that soil disinfestation by means of steam can be adapted to Puerto Rican conditions. Its successful use in other countries makes it a very satisfactory treatment under certain conditions. Atkinson (2) in 1895 suggested the use of steam for the control of damping-off in plant beds in severe cases. Gilbert (14) finds steam sterilization to be the best means of preventing tobacco root-rot. Clinton (7) comparing steam sterilization with the formalin drench in the control of tobacco root-rot found the steam treatment of beds as effective, with the additional advantage of being more efficient in killing weed seeds. Johnson in 1914 (19) in studies on the control of damping-off in plant beds with special reference to tobacco damping-off (*Pythium debaryanum* or *Rhizoctonia*) compared steam disinfestation with other means of treating beds, and concluded that the former was the most satisfactory method of preventing the disease.

In our opinion Puerto Rican growers will not resort to this means of eradication of the damping-off pathogenes. The economic conditions in the tobacco regions are more and more pressing every year and expense is the most important item. The cost of machinery and equipment needed in the treatment of plant beds by the steaming method is so high that it is prohibitive even for the more wealthy growers. It might be possible to introduce it by cooperative undertaking; but it is improbable that this will be accomplished.

The formaldehyde drench

History

It is generally admitted that the treatment of soils with a formaldehyde solution is an effective method in the control of fungus seedbed troubles. This disinfestant was first employed in eradicating soil fungi by Selby (24), in 1889 and 1900. He applied it to soils infested with the onion smut fungus *Urocystis cepulae* Frost. Later in 1906, this same investigator (25) recommended the treatment for the control of Rhizoctonia bed-rot and Thielavia root-rot on tobacco seedlings. It consisted of applications of a formaldehyde solution

(2½ pounds of 40 per cent fomaldehyde in 50 gallons of water) at the rate of 1 gallon per square foot of bed surface. The concentration is much weaker than that now recommended. This appears to have been the first attempt to control tobacco seed-bed troubles by the use of formaldehyde. In 1907 Clinton (l. c.) obtained good results with formaldehyde in the treatment of plots and crocks for the control of the Thielavia root-rot of tobacco. He used a 1–100 solution and applied it at the rate of 1 gallon to the square foot. Clinton says, "We believe that the formalin treatment is a very efficient and convenient method of protecting tobacco beds against root-rot and possibly the damping-off trouble." Yet, Selby (l. c.) had found the damping-off fungus (*Pythium*) occurring in treated seed-beds.

In 1909 Gilbert (l. c.) reported the results of beds treated with 1–200 and 1–300 solutions at the rate of ¾ gallon per square foot for the control of tobacco root-rot as only a little better than the untreated. In the same publication he states that a 1–100 solution might be used advantageously. In 1914 Johnson (l. c.) reported effective control of damping-off (*Pythium debaryanum* or *Rhizoctonia*) of tobacco with 1–50 formaldehyde solution applied at the rate of 2 quarts per square foot of surface. This is the concentration and rate recommended today.

Many other papers have appeared recommending formaldehyde for the eradication of damping-off. Among these there is one by Chapman (6) for tobacco damping-off.

Although the formaldehyde disinfestation of tobacco seed-bed soils in Puerto Rico seems prohibitive on account of the cost, experiments have been made to determine the efficiency of the treatment as practiced in other countries in the control of damping-off.

Experiments in Puerto Rico

(1) A set of trials was started in December 1926 as follows: twelve flats 2 ft. × 2 ft. and one foot deep were filled with a soil mixture containing about 50 per cent barnyard manure. Ten of these flats were drenched with a 1–50 formaldehyde solution, at the rate of two gallons per flat or ½ gallon per square foot of soil surface. Two flats remained untreated and kept about 10 yards away from the treated flats. The treated flats were covered with burlap for about 2 days. Tobacco seed was sown in the twelve flats a week after treatment. The notes taken a month after germination were as

follows: complete damping-off in the two untreated flats, some damping-off in four of the treated flats; six of the treated flats were healthy. (2) This experiment was repeated in flats where the chances of contamination after treatment were obviated. They were raised about 2 feet from the ground on a wooden platform. The flats were surrounded by frames of cell-o-glass (impermeable screen) about two feet high and nailed tightly to the sides of the boxes. Another frame was employed as a cover. The soil used was the same as for the first experiment. Six such flats were treated with the 1–50 formaldehyde solution, one was kept as a check. Damping-off occurred virulently in the check flat and in two of the treated flats. (3) In a third case data was obtained on 10 flats totalling about 90 square feet of surface which had been treated with a 1–50 formaldehyde solution at the rate of 1 gallon per square foot and planted with "Virginia Blanco" tobacco seed. Damping-off appeared in the flats about two weeks after germination of the seed. Reinfestation of the soil may have occurred, although this is not very probable. (4) In a fourth experiment 8 flats (5 ft. × 3 ft.) were disinfested as above in October 1927. The flats were covered with cell-o-glass movable frames soon after disinfestation. The flats were watered liberally, twice a day. Final observations on November 26, 1928 showed no damping-off in any of the flats. (5) A fifth experiment was started in the latter part of November and completed in December of 1927, using cultures of *Phytophthora Parasitica* and *Pythium debaryanum* for infesting the soil which contained in itself a high percentage of barnyard manure. The cultures were about one week old, vigorously growing in oatmeal agar. Each flat received 500 cc. of the culture. Six flats 5 ft. × 3 ft., were used, two for each one of the pathogenes and the remaining two as uninfested checks. The four infested flats and one of the checks received an application of 1–50 formaldehyde solution at the rate of one gallon per square foot of soil surface. This was made two weeks after infesting the soil. It was found in this trial that the *Pythium debaryanum* flats and the treated check flats were healthy at the end of the experiment; the *Phytophthora Parasitica* flats developed small areas of the disease; while the untreated checks developed damping-off which soon killed all the seedlings. (6) In a sixth case observations were made and notes taken on a one-acre tobacco plant bed disinfested by the Porto Rican Leaf Tobacco Co. with a 1–50 formaldehyde solution at the usual rate. The treatment was made in

December of 1927 soon after clearing part of a field which had been growing a tobacco seed-bed sown early in the fall. When the last notes were taken on January 20, 1928, damping-off had appeared in some of the treated beds. This occurred after a rainy period. Generally the treatment was effective. It may be noted that the application was not as thorough as is recommended, when one considers that most of the ditch space was left untreated. Then also the spread from one ditch to the other by the feet and shoes of the laborers who attend to the watering and weeding is an important factor not to be overlooked. The weather was, however, especially unfavorable for the development of the disease; rains were light and there was maximum sunlight. Therefore, the rather unsuccessful results in this trial must not be attributed to the treatment alone but the other factors influencing the severity of the disease must be considered.

Summarizing our own experiments and experiences with the formaldehyde treatment, it is concluded that: (1) a 1–50 concentration applied at the rate of ½ gallon to the square foot of surface is not an absolute disinfestant for soils infested with *Pythium debaryanum* or *Phytophthora Parasitica*, at least under Porto Rican conditions. (2) Formaldehyde at a 1–50 dilution and applied at the rate of 1 gallon per square foot is probably ineffective in eradicating the pathogenes. (3) *Phytophthora Parasitica* appears to be slightly less susceptible to the sterilizing action of formaldehyde than *Pythium debaryanum*. (4) The results of treatments are always shifted one way or the other by environmental conditions. (5) The location of plant beds in the island is such that reinfestation is very apt to occur at the time of the heavy rains. Infested soil may be washed down the hills into the beds. Under such circumstances the disease will develop and spread rapidly in the formaldehyde-treated soil. (6) The method is too expensive and, therefore, inapplicable in Puerto Rico.

Other Chemical Treatments

History

On tobacco beds Johnson (l. c.) reported benefit from the application of 0.4 per cent and 0.5 per cent sulphuric acid by weight. This amount he held to be as high as could be used in order to permit the germination of the seed. It appears that the little work done with sulfuric acid on tobacco damping-off has been unsuccessful.

In 1907 Horne (17) recommended the use of Bordeaux mixture for combating the damping-off of tobacco seedlings. Later in 1908

he (18) gave the treatment and preparation of the mixture in more detail. He used 6 lbs. of copper sulphate and 15 lbs. of slaked lime paste in 50 gallons of water, applying 1 gallon of the mixture to every 10 square feet of soil surface. This seems to be the first attempt at a practical solution of the problem of tobacco seed-bed troubles with chemicals other than formaldehyde.

In 1914 Johnson (l. c.), in experiments on the control of tobacco and garden cress (*Lepidium sativum*) damping-off, found inhibitory action on germination of seedlings with lime-sulfur, potassium sulphide, copper sulphate and mercuric chloride treatments. For this reason he thought there was little value in those disinfestants as soil fungicides. In the same experiments he obtained a decided decrease of the disease in soil treatments with Bordeaux mixture.

In 1919 d'Angremond (10) stated that tobacco could be protected in the nurseries with Bordeaux spraying and, later in that year, he (11) gave results of treatments of dessa manure or native compost for the destruction of *Phytophthora Parasitica*. He used benzine at the rate of 2.5 liters per cubic meter with no favorable effects; but his application of 510 grams of carbon bisulphide to the cubic meter was quite successful. This same worker (12) reported in 1920 the treatment of manure with copper sulphate as inadequate but carbon bisulphide was again successful. The latter treatment is, however, not practicable.

In 1925, Cook (8) recommended the use of 5–5–50 Bordeaux mixture, applied every 3 or 4 days for the control of tobacco damping-off. No information on the quantity of spray per unit area was given.

Major (22) found mercury compounds were injurious to tobacco plants in seed-beds when he used it for the control of the Thielavia root-rot.

In 1926, Bunker (3 and 4) advocated the Bordeaux mixture treatment but applied every 2 or 3 days. He did not give the amounts of the mixture to apply.

Thomas (26) controlled damping-off of tomatoes caused by *Phytophthora* sp. with copper carbonate, mercuric chloride and Uspulun. Mercury compounds were effective against Rhizoctonia in cabbage and tomatoes; copper carbonate and two forms of colloidal copper were ineffective in controlling this disease.

Lucca (21) has more recently reported control of tobacco damping-off with treatments of a 5–8–50 Bordeaux mixture. He says spray-

ings were made every 3 or 4 days but fails to give the amount of the spray per unit area.

More recently Doran (13) has found that he can protect tobacco against black root-rot and damping-off with an application of 1 to 1.2 per cent acetic acid solution at the rate of one-half gallon per square foot.

It is evident from the foregoing review of most of the investigations and reports on treatments for tobacco damping-off that formaldehyde and acetic acid are, in a general sense, effective treatments against damping-off of tobacco, but the objection raised against them is their inefficiency in protecting seed-bed soil from reinfestations that usually follow. To be applicable, cost excepted, to conditions in our country, a system of more or less permanent seed-beds should be installed whereby the soil, once disinfested, could be protected from reinfestations. As previously stated, the main disadvantage would be in the cost of the treatments. The Puerto Rican growers are in need of cheaper methods of control. The use of mercury compounds has been discouraging on tobacco seedlings, injury having been reported. Bordeaux mixture has been used to advantage in Cuba and in Puerto Rico, but the details of the treatment have not been worked out on the basis of its usefulness, practicability and economy. Recently some new copper dusts have been tried by Thomas (l. c.) against the damping-off of tomatoes and other vegetables with such beneficial effects that it appeared to us that they might be promising in the control of our tobacco seed-bed troubles. These have the very desirable quality of being applied in the dust form, doing away with the inconveniences of spraying. This virtue is to be courted in any disinfesting treatment for soils.

A number of copper and mercury compounds have been used in our experiments with formaldehyde as a check. Mercuric chloride and two organic mercury compounds whose commercial use is probably prohibitive, have been used for the sake of comparison. Acetic acid has also been employed in the experiments.

In the following experiments, unless otherwise stated, the flats used were about ten inches deep. They all were protected from unnecessary insolation by cheesecloth shade. Ample drainage was afforded by means of ditches between the beds and flats. In every case much care was exercised to prevent the spread of the pathogenes from one bed or flat to the other. The seed was mixed with cottonseed meal to facilitate even distribution.

Experiments with Corona Copper Carbonate

The copper carbonate dust employed in the following experiments contains about 20 per cent metallic copper.

Experiments in flats and experimental beds

In all experiments, unless otherwise specified. the soil was a compost made of six parts of heavy loam, one of well rotted barnyard manure and one part of sand.

Rate of application. Five sets of four flats each, 5 ft. × 6 ft. × 1 ft. were infested with isolates P 1, P 2, P 3, and P 10 and P 13, while a fifth set of four flats was left uninfested to serve as checks. An application of ½ gram, 1 gram, 2 grams, and 4 grams per square foot, respectively, of the chemical was made in each set of infested flats. It was dusted over the surface uniformly with a fine-mesh sieve and then well raked into the upper inch of soil. The soil was kept moist in all the flats. The twenty-five flats were sown thickly with Connecticut Round Tip seed two weeks after treatment. All the flats were kept well watered during the course of the experiment. Observations were made at short intervals.

Two weeks after germination, it was found that damping-off was quite severe in nearly all the flats. A second application was made to all flats (except the checks) at the same rate as before.

The dust from the second application was well washed into the soil by sprinkling the plants with water. The results are given in Table 1.

At the end of the experiment it was evident that: (*a*) all seedlings in the checks were affected; (*b*) the majority of plants died in the flats infested with P 1 and P 3 and treated with 2 applications of ½ gram, 1 gram, and 2 grams per square foot of surface; (*c*) the majority of the plants died in flats infested with P 2 and P 10 and P 13 when applications of ½ gram and 1 gram were made; (*d*) a fair control of the disease in flats with P 1 and P 3 when 4-gram applications were made and in those with P 2 and P 10 and P 13 when either 2- or 4-gram applications were made.

In another experiment with Corona copper carbonate, the dust was applied to the beds (20 ft. × 3 ft.) at the rate of four grams to the square foot of surface. The first application was made one week before the seed was sown and a second application followed two weeks after germination of the seed. In this experiment three beds were infested with a mixture of cultures of *P. debaryanum* and *P. Parasitica;* and of these beds one was left as a check. At the time when seedlings were of transplanting age no disease was ob-

served in the treated beds, while the seedlings in the check bed had been mostly destroyed. (See plates XXX, XXXI and XXXII.

TABLE 1

EFFECT OF CORONA COPPER CARBONATE ONE APPLICATION A WEEK BEFORE SOWING OF SEED, A SECOND 2 WEEKS AFTER GERMINATION

Application per sq. ft.	Results—Severity of Disease							
	P-1		P-2		P-3		P-10 & P-13	
	March 21	April 11	March 21	April 11	March 21	April 11	March 21	April 11
½ gram ..	2 diseased areas	90%*	1 diseased area	95%	2 diseased areas	90%	3 diseased areas	90%
1 gram.	3 diseased areas	90%	2 diseased areas	90%	2 diseased areas	90%	3 diseased areas	90%
2 grams	2 diseased areas	90%	1 diseased area	40%	1 diseased area	80%	1 diseased area	30%
4 grams . .	3 diseased areas	30%	3 diseased areas	10%	1 large diseased area	10%	2 diseased areas	10%
Check.	4 diseased areas	100%	1 diseased area	100%	5 diseased areas	100%	4 diseased areas	100%

*The percentages given are for estimates of the area of seed-bed destroyed.

Judging from the results of the above experiments it would seem that two applications of 4 grams of copper carbonate, one before sowing the seed, and the other two weeks after germination might control the disease. It appears also that even 2-gram applications will be sufficient to control *P. debaryanum* (P 2).

Time of application and effect on disease control. In order to test the effect of Corona copper carbonate when applied at various times before and after seed sowing, eighteen flats, 7.5 ft. × 3 ft., were infested with *Phytophthora Parasitica* prior to treatment and seeding.

One set of three flats was selected as check and the remaining five sets of three flats each were treated in the following order: set No. 1 three weeks before; set No. 2 two weeks before; set No. 3, one week before; set No. 4 at time of sowing; and set No. 5 one week after sowing.

At the end of three weeks after germination the disease had appeared in all the flats and, therefore, a second application of four grams of the dust was made on all flats except the checks. The disease continued with great severity. The final observations were made two weeks after the second application and seedlings which still remained apparently healthy were removed and examined for lesions. Only those seedlings showing no lesions were classed as healthy. The percentage of healthy seedlings in the stand at the close of the experiment was as follows: set No. 1: 14.98, set No. 2: 12.44, set No. 3: 5.35, set No. 4: 11.09, set No. 5: 20.06, and

check 2.09. It should be noted that these figures do not represent the percentage of the original population. The figures of healthy seedlings on the basis of the latter would have been extraordinarily small.

The results show that there was no effect of time of application of dust on control. An only slightly but not significant favorable effect occurred when the dust was applied three weeks before the time of seed sowing. From these results it would seem that two applications of 4 grams of copper carbonate are not effective in the control of damping-off, a conclusion which is not in harmony with previous results.

Relations between amount of water and effect of treatment. With the purpose of determining the relation between different amounts of water and the effect of copper carbonate on seedlings, twelve flats (5 ft. × 3 ft.), protected from the rain by cell-o-glass frames, were treated with 3 grams of the dust and watered as follows:

Flats Nos. 1 & 5—1 gallon of water. Morning.
Flats Nos. 2 & 6—1½ gallons of water. Morning.
Flats Nos. 3 & 7—2 gallons of water. Morning.
Flats Nos. 4 & 8—2½ gallons of water. Morning.
Flat No. 9—1 gallon of water. Morning and afternoon.
Flats No. 10.—1½ gallons of water. Morning and afternoon.
Flat No. 11—2 gallons of water. Morning and afternoon.
Flat No. 12—2½ gallons of water. Morning and afternoon.

The quantities of water given are in each case for the entire flat, i. e., for 15 square feet of surface. It may be noted that the amount of water in the soil at the beginning of the experiment was not determined, but the soil was fairly moist.

The results may be summarized as follows:

(*a*) Better development of seedlings in flats 9 to 12 where two waterings were made than in the flats 1–8 (one watering).

(*b*) Flat No. 9 with only one gallon of water for each application, resulted in less germination and the seedlings made less progress than in any of flats 10, 11, or 12, but the seedlings were healthy.

(*c*) Flats 1 and 5 had very few plantlets, but they were healthy.

(*d*) Flat No. 11, two waterings every day, made a slightly better growth than flats 4 and 8 which received one watering of a little higher quantity.

(*e*) The last and most important—there was no injury from the copper carbonate in any of the flats.

Field Treatments

A series of treatments were made under field conditions making applications of the copper carbonate at the rate of four grams to the square foot of bed surface. These trials were conducted on various farms of the Cayey–Aibonito tobacco section. In none of these was the dust applied before seed sowing and always after the disease had made its appearance. The seed-beds chosen represent conditions of both high and low infection.

Conditions of light infection. Two seed-beds in Aibonito in which damping-off had appeared, were treated in October 1927 with the dust at the rate of four grams to the square foot. The disease was evident as small rotted areas here and there. One of the seed-beds had an area of a little more than 7,000 square feet; while the other was of about 4,200 square feet. These treated beds in each case were surrounded by other beds which received no treatment. When treatments were made the plants had reached the stage when leaves are the size of a half-dollar. The observations in both trials showed that the disease had not been checked and, therefore, a second application, at the same rate as the first was made two weeks later.

The results at the time when seedlings were transplanted showed no beneficial effects of the treatment. A general inspection of the series treated with copper carbonate and that without any treatment showed many diseased areas in the latter, where seedlings had been almost completely destroyed by the disease. On the treated beds these diseased areas were less numerous and, seemingly, smaller in extent. More definite results were obtained by making counts of seedlings removed from portions of the beds in the two series. Two contiguous beds, one treated and a check, were selected. Starting at the lower portion of the seed-bed and about ten feet from the end of the bed, a sector three and one-half feet wide by two feet in depth was marked off. At intervals of 15 feet three other sectors were measured in like manner. This was done for both beds, so that one sector in the treated bed corresponded to a sector in the check. The healthy seedlings existing in the beds at the end of the experiment were pulled and counted. The results were as follows:

Sector	Treated bed	Check	Difference
1	638 seedlings	306 seedlings	332 seedling
2	712 seedlings	508 seedlings	204 seedlings
3	617 seedlings	611 seedlings	6 seedlings
4	681 seedlings	708 seedlings	-27 seedlings

These differences were studied statistically by Fisher's method

for the determination of significance of differences of means, and odds of less than 2 to 8 were found, indicating very insignificant results. It must be concluded, then, that the treatment was ineffective. Objection may be raised to the value of these results and the conclusions therefrom, since the observations can be regarded as insufficient. Yet the odds obtained were so low that had a larger number of observations been made, the results would have been found to demonstrate ineffective treatment.

The efficiency of the treatment was, no doubt, influenced negatively by the extremely favorable conditions of atmospheric and soil moisture which prevailed, and by the large quantity of seed which had been sown (5 lbs. to the acre), which tend to favor the increase, spread, and severity of the disease. It may be added that some of the chemical may have been washed away by the rains.

Two other field trials of two four-gram applications were made in Cayey, one in the Model Farm and the other in a private farm. The treated portion of the first seed-bed was about 2,830 square feet. At the time of the first application the seedlings were about three weeks old and several areas of the disease had appeared in various places. The second application followed the first by ten days.

Counts were made in the first seed-bed because the disease did not spread from the original spots in the treated beds and it was thought that the general stand and freedom from lesions was sufficient to serve as a basis for conclusions on the effect of the treatment. The untreated beds suffered severely from the disease and no plants were used for planting. This experiment was considered a success.

In the second trial counts were made as described above except that sectors were marked off at intervals of 10 feet instead of fifteen feet, and eight observations instead of four were made. The results expressed as healthy seedlings were as follows:

Sector	Treated beds	Check	Difference
1	232 seedlings	238 seedlings	-6 seedlings
2	221 seedlings	307 seedlings	-86 seedlings
3	532 seedlings	281 seedlings	251 seedlings
4	813 seedlings	453 seedlings	360 seedlings
5	691 seedlings	503 seedlings	188 seedlings
6	447 seedlings	553 seedlings	-106 seedlings
7	559 seedlings	564 seedlings	- 5 seedlings
8	837 seedlings	684 seedlings	153 seedlings

These differences when studied statistically by Fisher's method were found to be insignificant, with odds of only slightly over 4:1.

The treatment, according to the results of two experiments, was

unsuccessful while a checking of the spread of the disease was obtained in one experiment. Whether the conditions of infestation were higher in the check beds of this experiment where control was secured was not determined at the time the experiment was begun, but the random selection of the beds is in favor of the view that this did not happen. It may be concluded that the evidence from three field trials with copper carbonate applied to beds where there is slight infestation of the disease agents, shows that the treatment is unsuccessful.

Conditions of heavy infection. A section of a tobacco seed-bed (about 6,000 square feet) on a hillside in Cayey, with a severe infection of damping-off (about 40 per cent of the bed destroyed) was dusted with copper carbonate at the rate of four grams per square foot of surface. The results were unsatisfactory, probably due to the fact that the treatment was made when the disease was well advanced. It should be added that heavy rains prevailed during the time before and after the application of the dust.

Effect of Copper Carbonate on damping-off of vegetables

In the autumn of 1927, twenty-eight six-foot rows of young seedlings of tomato, eggplants, and pepper were found to be affected with damping-off, which proved to be caused by *P. debaryanum.*

The beds were dusted with copper carbonate at the rate of 4 grams per square foot as soon as the disease was discovered. A second application of the dust was made a week after the first. Daily observations were made henceforth until the time of removal of the plants to the field. The disease was checked by the treatment.

To check up these results, an experiment was planned in beds 20 ft. × 3 ft. where the soil was a rich loam which had received a light application of cottonseed meal. The soil was infested with cultures of *P. debaryanum* from tobacco. A week later an application of 4 grams of copper carbonate per square foot was well raked into the surface soil. Three beds were employed and each was divided into three subdivisions with partitions which were sunk ten inches below the surface of the soil. The middle portion in the outer beds (1 and 3) and those on the ends of bed No. 2 were left untreated. Eggplant, tomato, and pepper seed was sown in alternate lengthwise rows 4 inches apart in all the beds, except the last section of the third bed, a week after the treatment was made. The order of planting was tomato, eggplant, pepper; and the treated bed sections were planted first and later the checks, so that the rows in one series should correspond with those in the other. There were a total of eleven

rows of tomato and eggplant and 10 rows of pepper in each series; but notes were taken on 10 rows of each. The rows in the check beds were 7 feet long, those in the treated beds, 6.5 feet long; but seedlings were thinned out and only 300 of eggplant and 400 of pepper and tomato were left in each row. Germination was normal in all beds but some of the seedlings in both treated and untreated beds showed symptoms of the disease two weeks after germination. The disease became more serious and a second application was deemed necessary. A week after the first symptoms of the disease appeared, the second application (4 grams per square foot) was made. The disease continued for four days longer when a few seedlings were found to show symptoms. A week later no more seedlings were found dying. However, in the untreated beds the disease increased in severity. Records were taken of the total number of seedlings affected by the disease. Final observations were made when the seedlings were of transplanting age. The results are given in the following table.

TABLE 2

SHOWING RESULTS OF TREATMENT OF SOIL INFESTED WITH *P. debaryanum* WITH TWO FOUR GRAM APPLICATIONS OF CORONA COPPER CARBONATE

Bed Number	Tomato			Pepper			Eggplant		
	Healthy	Diseased	Per cent Healthy	Healthy	Diseased	Per cent Healthy	Healthy	Diseased	Per cent Healthy
1 Treated	1,011	189	84 25	1,107	93	92 25	574	26	95.67
2 Check	75	1,125	6 25	255	945	21 25	136	464	22.67
3 Treated	1,116	84	93 0	714	86	89.25	804	96	89.33
4 Check	93	1,107	7 75	94	706	11.75	114	786	12.67
5 Treated	654	146	81 75	1,155	45	96 25	777	123	86 33
6 Check	86	714	10 75	213	887	17.75	198	702	22.00
7 Treated	602	198	75 25	782	18	97.75	552	48	92.00
8 Check	34	766	4.25	162	638	20 25	154	446	25.67

In order to study the significance of the differences between treated and check beds the results expressed in percentages were paired so that a comparison was established between tomato from the treated beds and tomato from the checks; the same for pepper and for eggplant. Such a study showed that the differences were highly significant, the odds for tomato being well above 4999 : 1, for pepper over 9999 : 1, and for eggplant nearly 9999 : 1, when Student's method was employed. It can be safely concluded from the above data that two applications of 4 grams of copper carbonate applied as described above, will control *Pythium debaryanum* on tomato, pepper and eggplant.

That this treatment was more successful than those on tobacco

may be attributed to the less crowded conditions in the beds with the vegetables. In the latter the sun's rays reach down to the soil at least during the early susceptible stages of the development of the plant and help in drying up the surface layer. This drying up probably also is a factor in disinfestation.

Copper stereate

An experiment was carried out to determine the effect of copper stereate on the control of damping-off. Of fifteen flats (2½ ft. × 3 ft.); five were infested with oatmeal agar mass cultures of P 1, five with P 2, and five with P 3. One flat of each set was left as a check. The remaining four flats of each set were treated one each with 1, 2, 4, and 8 grams of the chemical per square foot, respectively. The seed was sowed a week later. Two weeks after germination damping-off had started in all the flats and therefore a second application was made.

When final notes were taken it was plain that the treatment had been ineffective in controlling *P. Parasitica* (P 1 and P 3) while apparently some control of *P. debaryanum* (P 2) as suggested by healthy seedlings, had been obtained when two applications of 8 grams per square foot had been applied.

A second experiment was conducted in which *P. debaryanum* (P 2) alone served as the damping-off pathogene. Three beds 20 ft. × 3 ft., were employed, of which two were treated with copper stereate at the rate of 8 grams per square foot and the third was left as a check. The seed was sowed a week after the application. Symptoms of the disease were evident ten days after germination, when a second similar application was made. The disease continúed unchecked in all the beds and extended to the majority of the seedlings before these had reached transplanting age.

It is concluded that copper stereate is ineffective in the control of the disease.

Uspulun

It was felt that treatment with organic mercury compounds might prove advantageous. Several experiments were made with Uspulun solutions of different concentrations.

In the first experiment three sets of five flats (2½ ft. × 3 ft.) were employed. The soil was infested with P 1, P 2, and P 3 isolates respectively. One flat from each set was selected as a check and the remaining treated each with the following concentrations of Uspulun: 1–300, 1–600, 1–1200 and 1–2400, one week before seed

sowing. The solutions were added in sufficient quantity to soak the soil.

Germination was normal in all flats except those treated with the 1–300 solution in which injury to the seedlings was very evident.

Symptoms of the disease appeared in all flats at an early stage and destruction was complete by the third week in all flats treated with the 1–200 and 1–2400 solutions. A second application was made on the 1–300 and 1–600 flats and this was followed ten days later by a third application. The disease continued unchecked.

The second and third 1–300 applications were injurious to the foliage. The results of this experiment showed that even three applications of a 1–300 Uspulun solution do not control tobacco damping-off.

A second experiment was devised with a 1–400 solution, using different quantities per square foot of surface. Four beds (20 ft. × 3 ft.) previously infested with cultures of the pathogenes, were treated a week before seed sowing and with a 1–400 solution, one each with ¼, ½, and one gallon per square foot, respectively, and the fourth was left as a check.

Germination was perfect in all the beds except that receiving the 1 gallon application, in which very few seedlings developed. The disease appeared in the beds and therefore a second application was made the third week after germination. This did not check the spread of the disease so that at the close of the experiment, three weeks after the second treatment, nearly all the plants had died. (See plate XXXII.)

It may be concluded that a 1–400 Uspulun solution at the rate of 1 gallon per square foot is injurious to seed germination, while at the rate of ¼ or ½ of a gallon it is effective in controlling the disease.

Bayer dust

A preliminary experiment was started with Bayer dust, an organic mercury compound. Four sets of five flats (2½ ft. × 3 ft.) were infested with Pythium and Phytophthora cultures one each with P 1, P 2, P 3, P 10 and P 13. In each set one flat was treated with Bayer dust at the rate of ½ gram, one with 1 gram, another with 2 grams and the fourth with 4 grams per square foot, while the fifth was left as a check. The seed was sown a week after treatment.

Germination was normal in all the flats. The first symptoms of the disease appeared three weeks after germination in all flats. A second application was then made.

The results at the termination of the experiment six weeks after germination, showed that Bayer dust was effective in the control of damping-off even when as many as two applications of four grams per square foot were employed.

The ineffectiveness of this treatment was further shown in an experiment with two four-gram applications of the dust. The beds used were 20 feet × 3 feet and infested with a mixture of oatmeal agar cultures of *P. debaryanum* and *P. Parasitica.* The first application was made a week before sowing the seed and the second was made two weeks after germination. Three beds were treated and one was left as a check. The results showed a complete destruction of the seedlings in the check as well as in the two treated beds. (See plate XXXIII.)

In order to determine if seedlings could be better protected by applications after germination only, the preceding experiment was duplicated using this time the 4 gram treatment only and making two applications, one a week after germination and the other following the first by 10 days.

At the close of the experiment no significant difference between treated and check flats could be found, indicating the non-effectiveness of the Bayer dust.

Copper sulphate

Three beds (20 ft. × 3 ft.) were infested with a mixture of oatmeal agar cultures of P 1, P 2 and P 3 and after a week treated as follows: one with a solution of 2 pounds of copper sulphate in 25 gallons of water, the second with 2.5 pounds in 25 gallons, and the third was left as a check. The third bed was located between the first and second. The rate of application in the two cases was 1 gallon per square foot. Seed was sown a week after application.

Two weeks after germination there was a general occurrence of damping-off in all the beds and the disease continued until only a few scattered plants were left. This indicates the failure of copper sulphate at those concentrations to eradicate the damping-off fungi.

Copper fluosilicate *

Four beds (20ft. × 3 ft.) were prepared as in preceding experiments and infested with a mixture of cultures of *P. debaryanum* and *P. Parasitica.* Three were treated one each with 2, 3 and 4 grams of the dust, respectively, per square foot. The fourth bed was kept as a check. Seed was sown ten days after treatment.

* The copper fluosilicate compound used in this experiment is not manufactured any longer.

A second application of the dust was made three weeks after germination when it was clear that the disease was making headway in all the beds. The dust from the second treatment produced a burning of the foliage of a large number of seedlings but checked the disease in the beds receiving three and four-gram applications. (See plate XXXIV.)

In conclusion, it may be said that copper fluosilicate did not have a deleterious effect on the germinating seedlings. When applied after germination it burned the foliage of the plantlets. Two applications of 2 grams per square foot were not enough to control the disease. Two applications each of 3 and 4 grams of the chemical, one a week before sowing the seed, the other four weeks after seed sowing gave good control.

Acetic acid

Three beds (20 ft. $\times$ 3 ft.), where tobacco seedlings had died from damping-off, were treated as follows: No. 1 with one per cent acetic acid, and No. 2 with 1.2 per cent acetic acid, both at the rate of one-half gallon per square foot, while the third bed remained untreated. The concentrations used here are those used by Doran (13) and which he gives as resulting in good control of the damping-off of tobacco.

The seed was sown ten days after treatment.

The observations made after germination showed that the disease appeared twelve days after germination and progressed rapidly until the experiment was terminated when it had spread completely over all the seedlings as in the case of the check bed. The failure of acetic acid to control the disease in Puerto Rico under conditions of high infestation is clear.

Bordeaux mixture

Since Bordeaux mixture had been reported as giving good control in Puerto Rico and Cuba it was deemed desirable to make tests with it under controlled conditions. For this purpose three of the common formulas were used, namely, the 3–3–50, 4–4–50, and 5–5–50. Eight beds (20 ft. $\times$ 3 ft.) which were heavily infested with cultures of the pathogenes were treated, two each with each formula and the remaining two were left untreated. The rate of application was one-half gallon per square foot. Seed was sown a week after the treatment.

Germination was excellent in all beds. Two days after germination a few small areas of the disease were observed, and then a

second application at the same rate and formula as the first was made on all the treated beds.

The results show complete damping-off of seedlings in the check beds, about 25 per cent infection in the 3–3–50 beds and about 5 per cent infection in the 4–4–50 and about 5 per cent in the 5–5–50 beds. (See plates XXXV and XXXVI.)

From these results it may be concluded that two applications of 4–4–50 or 5–5–50 Bordeaux mixture, at the rate of ½ gallon per application per square foot, serve as good protectants against damping-off. These applications should be made one before sowing the seed and the other ten to fourteen days after germination.

A further test was made with Bordeaux mixture (4–4–50), on five beds on which the disease had appeared. The diseased areas were treated with 1–30 formaldehyde and then the first application of the bordeaux mixture was made at the rate given in the preceding experiment. The disease continued to spread over the beds so that a second application was made two weeks later.

These beds were exposed to heavy rains so that some of the mixture was undoubtedly washed away.

The results showed that the disease was not completely checked by the two treatments but the treated beds showed a great improvement over the surrounding untreated beds where all the plants were affected.

It may be concluded from these results that applications of Bordeaux mixture (4–4–50) after the disease has made its appearance in a seed-bed do not check completely any further spread though it reduces the amount of disease.

Injury from copper fungicides

In an experiment made in 1927 on beds in the field, where a crop of tobacco seedlings had previously been grown, it was found that injury resulted from an application of cooper carbonate. This is the first case of injury from this compound in any of our experiments. Six beds (120 ft. × 4 ft.) had been treated with the dust at the rate of four grams per square foot, one week before seed sowing. The beds were well watered during all the time the experiment lasted. It should be added that the neighboring beds, making a total of about one acre, were treated with 1–50 formaldehyde at the usual rate.

The injury in the copper carbonate-treated beds was manifested in much delayed germination and the few seedlings that developed

were stunted and yellow. No injury resulted from the formaldehyde treatment under the same conditions.

The injury of the compound was not due to a too heavy application since it was the same as employed in all previous experiments with the same dust, in which no injury ever resulted. It can not be attributed to dryness since the beds were liberally watered twice a day.

An experiment was planned in 1928 in order to find out whether such deleterious action could be prevented. The conditions of the preceding experiment were duplicated as nearly as possible. A seedbed, on the same kind of soil (a heavy loam), which was growing a crop of tobacco seedlings was selected. It was assumed that the injury occurred either because too much copper became soluble or because some compound or substance was formed on these soils which was injurious to germination. The beds were cleaned in December, the soil reworked, and an application of a 6–7–8 fertilizer (nitrogen in the form of sulphate of ammonia and cottonseed meal) applied.

Besides copper carbonate, Bordeaux mixture was also used in the experiment. As checks to the copper disinfestants, acetic acid and formaldehyde were employed, the latter because no injury had followed this treatment on the same soil where copper carbonate had been injurious and the former because of the change in soil reaction which would be expected with its use. Charcoal was used as an absorbent.

The beds were 40 ft $\times$ 4 ft. and they were protected from insolation by a cheese-cloth shade. There was very little rain during the time the experiment was in progress so that it may be said that all the beds alike received a moderate amount of water. Watering was done once a day, in the morning. Soil samples for the determination of active acidity were taken a week before the application of the fungicides and again at the time injury first appeared in some of the beds.

The charcoal used in the experiment was very finely ground; it was applied at the rate of 1 ounce per square foot of surface on January 8. The disinfestants were applied January 11 at the following rates per square foot; copper carbonate, four grams; Bordeaux mixture (4–4–50), ½ gallon; acetic acid (1.2 per cent), ½ gallon; and formaldehyde (1–50), ½ gallon. Both the charcoal and the copper carbonate were incorporated by raking them well into the loose surface soil. The liquid solutions were applied with sprinkling cans.

The seed was sown in all beds January 24, 1929. The arrangement of beds, treatments, and results appear on Table 3.

TABLE 3

SHOWING EFFECTS OF CHARCOAL ON COPPER CARBONATE AND BORDEAUX MIXTURE-TREATED BEDS; ALSO EFFECT OF ACETIC ACID AND FORMALDEHYDE, SOIL OF OLD BEDS

Beds	Treatment	Results
1	Check	Normal development
2, 3	Charcoal alone	Normal development, slightly lower than check
4, 5, 6	Copper carbonate plus charcoal	Yellowing of seedlings, about 25 per cent of plants
7, 8, 9	Copper carbonate alone	Yellowing of seedlings, about 25 per cent of plants
10, 11	Checks	Normal development
12, 13, 14	Bordeaux (4-4-50) plus charcoal	Slight yellowing on about 5 per cent of plants
15, 16, 17	Bordeaux (4-4-50) alone	Slight yellowing on about 5 per cent of plants
18, 19	Checks	Normal development
20, 21	Acetic acid (1.2%) plus charcoal	Normal development, like checks
22, 23	Acetic acid (1.2%) alone	Normal development, growth more rapid than in check
24	Check	Normal development
25, 26	Formaldehyde plus charcoal	Normal development
27, 28	Formaldehyde alone	Normal development, more rapid than in checks; similar to beds treated with acetic acid
29, 30	Charcoal alone	Normal development, slightly slower than checks
31	Check	Normal development

It is plain that charcoal did not prevent the injurious action of copper carbonate and Bordeaux mixture. The fact that Bordeaux mixture was also injurious to seedlings grown under the same conditions as those of beds treated with copper carbonate or with no treatment at all, seems to indicate that copper is the toxic agent. Beds treated with formaldehyde and those with acetic acid were not only normal but the stand of seedlings and rapidity of growth surpassed that of the non-treated beds. Development in the beds treated with charcoal alone was slightly slower than that of the non-treated beds. This action of the charcoal was evident when beds treated with acetic acid or formaldehyde, with and without charcoal were compared. Growth was much more rapid where charcoal was not used.

It seems likely that the cause of the injury by the copper compounds can be attributed to some chemical reaction with the soil. The object of this experiment has not been to determine, through the proper chemical procedure, the real nature of the toxicity in question. Therefore, we shall point out only the probable cause or causes which the results in table 3 suggest. The favorable effect of formaldehyde and acetic acid as contrasted with the rather injurious tendency of copper carbonate and Bordeaux mixture, suggests that the latter treatments have alike induced a certain reaction to which may be attributed the injury produced on seedlings. The pH reaction of the soil may directly have little to do with these results. On discussing the general effect of the various treatments we can

draw the following considerations. The disinfesting action of formaldehyde and acetic acid is only temporary. Therefore, as they do not prevent secondary infestations their use is undesirable. It is obvious that the beneficial soil flora will regain its predominance without much difficulty. On the other hand, the disinfesting properties of copper carbonate and Bordeaux mixture are more lasting and it may be possible that the nitrifying organisms in the soil may cease to increase in numbers and their action be reduced. Were this to occur the whole question might be referred to nitrification. The condition of the seedlings would suggest starvation of some kind. Now, according to this assumption, the injury in the beds treated with the copper compounds occurs because nitrification is prevented. In those not so treated or where either acetic acid or formaldehyde were applied, nitrification proceeded after the treatment. That this injury does not occur in new land or in soils not previously growing a tobacco seed-bed, may be given further in support of this assumption. A soil in which a tobacco seed-bed has been growing is almost depleted of its nitrates as evidenced from the failure of a second crop immediately following the first. The success of the second seed-bed, then, depends entirely on the nutrients rendered available during the time it is in progress. If any difficulty arises whereby these nutrients are prevented from being incorporated in an available form, the failure of the crop may be expected.

In an experiment conducted in flats in the greenhouse in the fall of 1931 injury from Bordeaux mixture was again observed. Two flats were sprayed weekly for three weeks with a sodium nitrate solution (1 ounce to 1 gallon). The majority of the seedlings recovered and made normal growth. No further experiments were carried out and these results must, therefore, stand only as a suggestion for more controlled experiments.

In connection with injury resulting from copper it may be added here that Mme. Vladimirskaya (30) in studies on the action of various methods of soil disinfestation upon the physical and chemical constitution of the soil, found that among other substances copper carbonate had a deleterious effect on nitrification. She further found that formaldehyde at first suppressed but later stimulated the development of the nitrifying flora of the soil. Our results and observations appear to be in line with her results.

Summing up, in our opinion it may happen that the fertilizer added to a soil which is later treated with a disinfestant of lasting effect, is not rendered available and therefore the seedlings can make no use of it.

Effect of cultivation

It was thought that constant cultivation for a period of five or six months might reduce the amount of infestation in a soil. If possible this would be a practical means of eradication which farmers in Puerto Rico would not hesitate in putting into effect.

An experiment was started in 1928 with a view of ascertaining the effect of cultivation. Two beds, where some chemical treatments had been unsuccessful, were chosen because these were known to be heavily infested. In one of the beds subdivided into three sections, copper sulfate and Uspulun solutions had failed to control the disease and in the second bed Bayer dust and mercuric chloride had been unsuccessful in experiments which lasted until March 26. A third bed which had had damping-off all the time was selected as a check. The size of the beds was 20 ft. $\times$ 3 ft.

This experiment was begun on April 15. The three beds were sown on that date, because we wanted to know the degree of infestation of the beds at the time the experiment was commenced. The germination in the beds was excellent but damping-off began to appear on the young seedlings soon after they emerged. All the seedlings had been killed by May 10, when two of the beds were weeded and the soil loosened up well with a spade and rake. The third bed was left unweeded throughout the time the experiment lasted. The two treated beds were weeded twice a month when the soil was again loosened up. This continued until Nov. 15, when the check bed was also weeded and the soil put in shape for the sowing of the seed. There was good germination in all the beds. Damping-off appeared in the three beds simultaneously on Nov. 26, and spread very rapidly. On Dec. 6 more than 76 per cent of seedlings had been killed in each of the three beds and destruction was complete by Dec. 10.

The results show that about six months of constant cultivation of an infested soil does not reduce the amount of infestation of the damping-off pathogenes.

To test whether the treatment would be efficacious over a period longer than six months, the same beds were similarly treated from Dec. 10, 1928 to Dec. 10, 1929. The seed was again sown. The disease appeared again. When the experiment was closed, i. e., when plants were of transplanting size, not less than 60–70 per cent of the stand had been destroyed by the disease, which shows that even a year of continuous cultivation fails to eradicate the disease.

This experiment was not conducted over a longer period because

it was realized that even one year of such a treatment would be highly impractical in Puerto Rico.

Protection

The experimental part on protection has been given with that on eradication. In tobacco damping-off, it appears that a definite, clearly cut line cannot be drawn between protection and eradication. They are, in our minds so linked to each other that a discussion of the data separately would detract very much from the value and meaning of the same.

With the eradication of the damping-off pathogenes naturally goes the destruction of the majority of the organisms constituting the soil flora, thus breaking the equilibrium which must normally exist among these soil inhabitants. A reinfestation by the pathogenes causing damping-off may rapidly gain a foothold in the new habitat, the fungi spreading with much rapidity. Tobacco seedlings, under the conditions of moisture and temperature characteristic of those overcrowded plant populations, and with their high susceptibility offer these pathogenes the most favorable abode. It is clear that some means of insuring the best development of the seedlings must be provided. A barrier, therefore, must be erected between the susceptible plant parts (leaf, stem, and roots of seedlings) and the parasite. This may consist of some substance which when applied to the parts susceptible of penetration will kill the inoculum. Such a substance may also be applied to the environment where the pathogene is harbored or where it may extend into, checking its progress there. This aim might also be attained by modifying other external conditions or factors which influence the development, spread and severity of the disease.

Methods of protection to follow those of eradication have already been discussed in relation to the disinfestation experiments. It was found that copper dusts or compounds when applied to the soil and plants will protect the latter considerably from new attacks. The best methods of control are those which combine the means whereby the amount of inoculum in the soil is reduced to the minimum and which insures a relative amount of protection thereafter.

A discussion of other protective measures for seed-beds against damping-off may be found in the literature. The application of a layer of dry or hot sand to the surface of the beds after the seed is sown will give good results in connection with the damping-off of other seedlings like citrus and vegetable garden crops; but with to-

bacco, the seed of which is very small, it will probably be inapplicable, aside from being too costly on a large scale. It seems that the avoidance of organic matter, especially fresh barnyard manure, will do much good in preventing the disease. Yet a clean bed when enriched by the addition of uninfested manure will be as safe as any other soil, and, besides, will give strong, rapidly developing plants. Any uninfested seed-bed may be protected from infestation by digging a wide trench or ditch on all sides and especially on that side from which, the drainage water is expected to run. This ditch must be wide and deep enough to take care of all the superfluous surface water during heavy rains. It should drain away from the seed-bed, and under no circumstances should lateral ditches be allowed to drain through the beds.

Great damages will be prevented sometimes by clean and careful culture. Weeding should be done as carefully as possible. There is often more harm resulting from careless weeding than the good which should follow the removal of the weeds. Before proceeding to weed a field a careful inspection of the bed should be made and wherever symptoms of the disease are detected the diseased areas should be drenched with a 1–30 formaldehyde solution. This done, the beds may be weeded without danger, unless the pathogenes have already spread too far away from the treated areas at the time these were detected. It is always a good practice to apply the disinfestant even beyond the zones of infection. Persons handling diseased plants should wash their hands in a disinfecting solution, then in water before going into healthy beds. Any tools used in such beds should be sterilized in a formaldehyde solution before using them in other beds. Wet, low places in seed-beds are usually a source of inocula. The disease will first appear here and the inoculum is then transported by the many agents into other beds. All such wet spots should be avoided when looking for a suitable site for the beds. When they cannot be avoided they should be drained well and the drainage ditch should empty into the outside. Pools of water should not be allowed to form in the ditches because they are often the sources of inocula.

Summary

1. Damping-off of tobacco is a very severe disease in Puerto Rico.

2. The disease is caused by *Pythium debaryanum* and *Phytophthora Parasitica* var. *nicotianae.*

3. The agents of transportation of the fungus are water currents, laborers, animals, burrowing insects, etc.

4. Leaves are infected by zoospores of *Phy. Parasitica* var. *nicotianae* but apparently not by those of *P. debaryanum*.

5. Environmental conditions are important factors influencing the spread and severity of the disease. The disease seems to be equally severe during all seasons provided the proper moisture relations are maintained. Organic manures seem to influence favorably the incidence of the disease. The disease is severe on thickly-sowed beds.

6. Control of damping-off of tobacco is today one of the most serious problems with Puerto Rico tobacco growers.

7. When the disease appears in small areas only, it may be checked by drenching these with a 1–30 formaldehyde solution.

8. Soil disinfestation by means of steam or with formaldehyde does not seem to be practicable under Puerto Rican conditions.

9. *Phy. Parasitica* var. *nicotianae* is probably slightly less susceptible to the sterilizing action of formaldehyde than *P. debaryanum*.

10. Mercury compounds have been found injurious to tobacco seedlings, and ineffective against the damping-off pathogenes.

11. In preliminary trials two applications of Corona Copper carbonate of four grams per square foot, before seed sowing, and at the same rate a week after germination, were fairly effective.

Two applications of copper carbonate in the field did not give effective control probably due to the heavy rains and to overcrowding of the seedlings. Two late applications of copper carbonate on heavily infected beds were unsuccessful. Two 4-gram applications of copper carbonate resulted in good control of the damping-off of tomato, pepper, and eggplant.

12. Copper stereate, in two applications of 4 grams each, seemed to control *P. debaryanum* but did not have any effect on *Phy. Parasitica* var. *nicotianae*.

13. Bayer dust and Uspulun were injurious when applied to the foliage and proved to be ineffective in the control of the disease.

14. Copper sulfate solutions (4 and 5 pounds to 50 gallons), applied at the rate of ½ gallon per square foot before sowing the seed were ineffective.

15. Effectiveness of copper fluosilicate is doubtful.

16. Acetic acid does not control the disease under conditions of high infection.

17. Two applications of 4–4–50 and 5–5–50 Bordeaux mixture at the rate of ½ gallon per square foot, one before sowing the seed and the other a week after germination, were effective in controlling

damping-off. The treatment was not very successful when applied to beds in the field in which the disease had made its appearance.

18. Injury to seedlings resulted when copper carbonate was applied to a tobacco seed-bed on the site of an old bed. It was proved by experiment that the injury was not due to dryness. Soil reaction appears to have little to do as a direct cause of the injurious action. No injurious action of formaldehyde or acetic acid was found under similar conditions. Charcoal was not effective in preventing injury from the copper compounds. Recovery from injury resulted in one case when a sodium nitrate solution was applied. It is suggested that the injurious action is connected with nitrification which would be hindered by the lasting effect of the copper treatments.

19. Continuous cultivation of infested soils for periods of six to twelve months does not eradicate the disease.

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Explanation of Plates

Plate XXVII. Healthy tobaco seedlings.

Plate XXVIII. Tobacco seedlings showing lesions produced by infection with *Phythium debaryanum*. Note that they are confined to the region of the stem at the soil surface.

Plate XXIX. Tobacco seedlings infected with *Phytophthora Parasitica*. Note that the lesions may occur higher up the stem than the surface of the soil.

Plate XXX. Bed treated with four grams of copper carbonate (Corona) at the time of seeding and two weeks after germination.

Pate XXXI. Another bed treated with four grams of Corona copper arbonate a week before seeding and two weeks after germination.

Plate XXXII. Bed treated a week before sowing seed with a 1–400 Uspulun solution at the rate of one-half gallon per square foot of surface.

Plate XXXIII. Bed treated a week before sowing the seed, with Bayer dust at the rate of 2 ounces per square yard. Note the complete destruction of seedlings with only a few at the lower corners surviving.

Plate XXXIV. An application of four grams of copper flousilicate made after the appearance of the disease resulted in good control though in injury to many seedlings.

Plate XXXV. Two applications of Bordeaux mixture (4–4–50) at the rate of one-half gallon per square foot, one at the time of seeding, the other two weeks after germination. Note the stand and vigor of the seedlings.

Plate XXXVI. Two applications of 5–5–50 Bordeaux mixture, one at the time of seeding, the other two weeks after germination. Rate of application, one-half gallon per square foot of surface.

Plate XXXVII. An infested bed from the checks. Note the almost complete destruction of seedlings. The majority of the seedlings showed infection at the time the photograph was taken.

PLATE XXVII

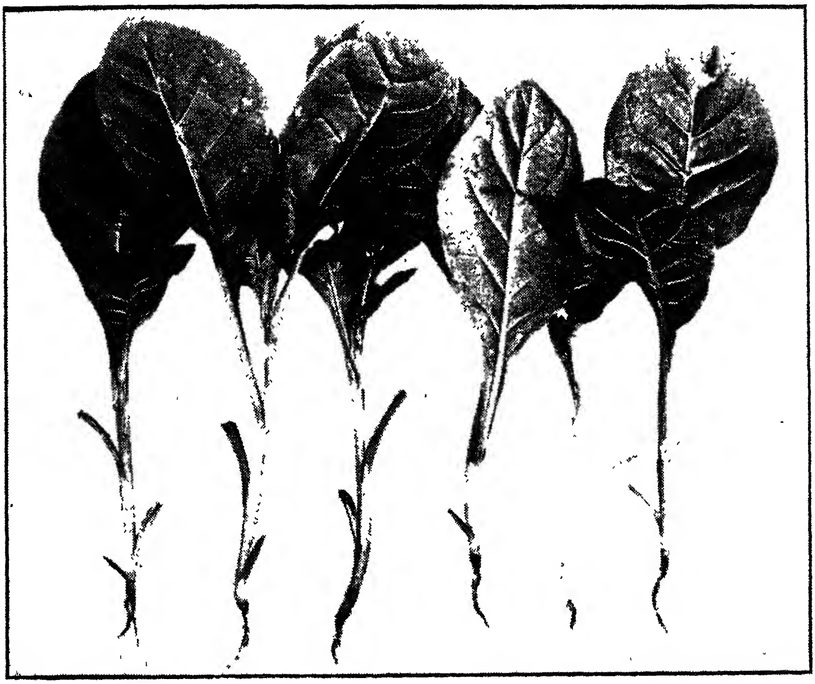

PLATE XXVIII

PLATE XXIX

PLATE XXX


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PLATE XXXII

PLATE XXXIII

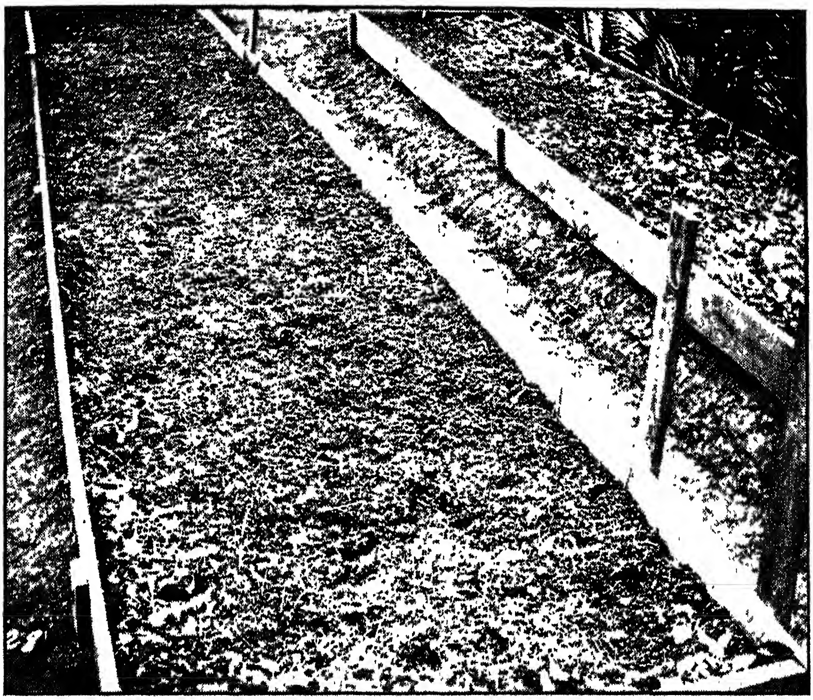
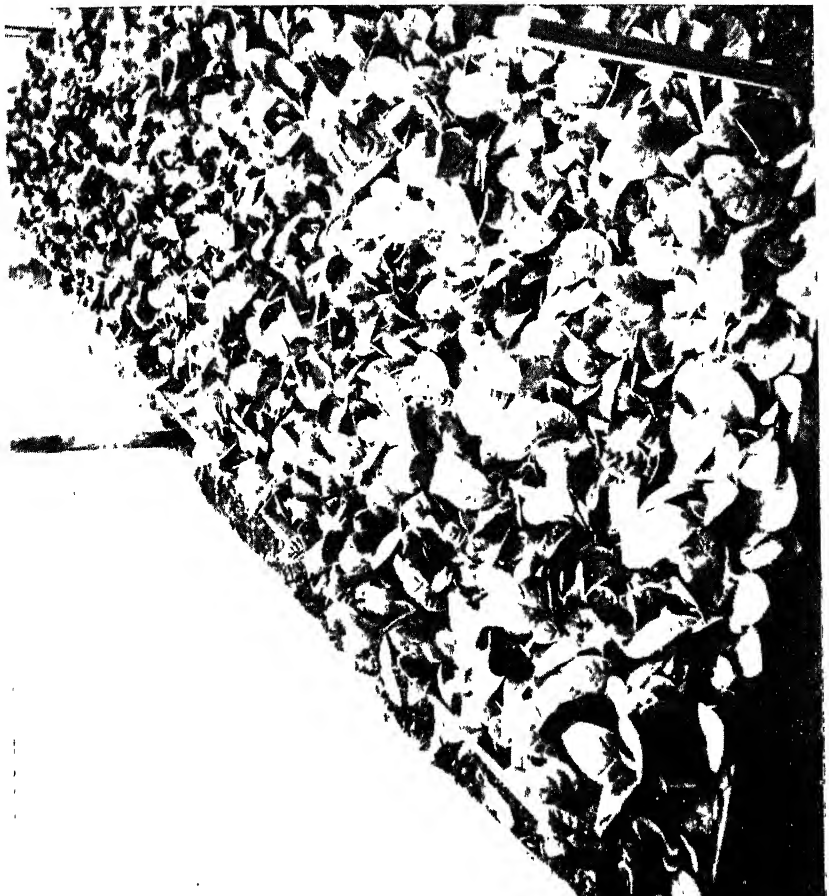


PLATE XXXIV

PLATE XXXV

PLATE XXXVI



18-2-8

A NEW FROG FROM THE VIRGIN ISLANDS,

CHAPMAN GRANT, *Major, U. S. Army.*

A recent ten-day collecting trip to St. Thomas, St. John, St. James and adjacent keys developed several new locality records and one new frog which may be called:

Eleutherodactylus cochranae sp. nov.

Type No. 5659. Chapman Grant Collection, 14 April, 1932, St. John Island, V. I.; collector, Chapman Grant.

Diagnosis: Distinguished from the other West Indian *Eleutherodactylus* by practical absence of vomerine teeth; short obtuse snout; small size of ear and its nearness to eye.

Habitat: St. John and Hassel Island, St. Thomas. Found in the axils of *Bromeliads*.

Proportions: Slender, medium size, 20 mm.

Description of Co-types: Habitus average, head slightly wider than body, eyes medium; limbs medium, relatively short, heels overlapping when legs are placed at right angles to the body; length vent to heel equal to about vent to posterior part of eyes. Vomerine teeth almost wanting. Tongue large, oval, not notched behind, free about half its length. Nostrils prominent, much closer to tip of snout than to eye; canthus rostralis not distinct, loreal area sloping, longitudinally concave, indistinct because of warty skin in this area; snout short and obtuse; distance between orbits about ¾ width of eye and about equal to eye to half way between nostril and snout; eye medium but equal to distance eye to snout; tympanum small, not distinct above, about ⅓ diameter of eye and nearly adjoins the orbit; fingers free with medium discs graduated, smallest on first finger; area of disc on fourth finger twice that of first; toes with medium discs, fourth and fifth decidedly larger than other three; no webs; tubercles small. Skin coarsely granular on belly which bears a disc, and on lower aspect of thighs; raised line from snout to vent, large warts on head and eyelids symmetrically placed and about five rows warts along dorsum; largest toe disc almost equal to tympanum in area and slightly larger than largest finger disc.

Color and markings: Above generally grayish brown with a complicated dark brown pattern, resembling the outstretched skin of a

wolf; usually a dark stripe from eye, over tympanum and front leg; rear aspect of thigh and lower surface of tibio-tarsal joint clear seal brown. Below light with fine brown specks on throat and thighs, belly nearly clear.

Measurements of type, which is an average adult: snout to vent 21 mm.; width of head 8 mm.; snout to posterior edge of tympanum 8 mm.; leg from vent 26 mm.; foreleg from axilla 12 mm.; hind foot 10.5 mm.

This species is found in the axils of tree-inhabiting *Bromeliads.* Thirty or more individuals sometimes being found in one plant. A very few *E. antillensis* were found with these on St. John but none on Hassel Island. This species has certain resemblances to *E. antillensis,* but many *E. antillensis* smaller than many of the present species had their own characteristics well marked. There seem to be many constant differences but the granulation of the lower side is similar.

I submitted this question to Miss Cochran who writes under date of July 12, 1932, "_______ is certainly not the young of *antillensis.* It has no well marked canthus rostralis, its snout is shorter, its ear is considerably nearer to the eye, it has practically no vomerine teeth, and it has no well-marked black reticulations behind the femur—in all of which characters it is decidedly different from *Antillensis*".

The voice of this species was not heard.

Remarks: Specimens taken, St. John, 210; Hassel Island, 45.

Named in honor of Doris M. Cochran.

This frog bears a superficial resemblance to *E. gryllus* of Puerto Rico in color and markings, but the head is wider in proportion.

NOTES ON THE BOAS OF PUERTO RICO AND MONA

CHAPMAN GRANT, *Major, U. S. Army.*

The two species herein treated seem very different in general aspect but show considerable similarity in squamation. The markings are really the surest and easiest means of identification, since most scale-counts overlap.

Dorsal spots neck to vent........ 70–80—*Epicrates inornatus.*
Dorsal spots neck to vent........ 51–60—*Epicrates monensis.*

The postoculars of *E. inornatus* are 4 or rarely 3. Of *E. monensis* 7 or rarely 6.

Epicrates inornatus (Reinhardt)

Very few specimens of this species have been preserved in collections, there being only about half a dozen in the United States. Stejneger describes the type and variations in a scholarly manner in "The Herpetology of Porto Rico". To his description is added the fact that the lining of the mouth and the tongue are black and the eyes of the young are bronze color.

The first specimen of my collection came from high up on Luquillo mountain. It is dark and of so uniform a color that the dorsal spots cannot be counted. Length 6′. The next two specimens were from the headwaters of the Mameyes River. Taken May 17, 1931. They mated the same day while being transported in a box. They would not eat, although a roomy cage with shelter was provided. Every imaginable food was offered them—small, live rabbits, small live chickens, live *Anolis*, cockroaches, milk, meat, fruit, eggs, etc. Finally they assimilated beef when force-fed. Upon being killed, July 20, 1931, the female was found to contain 32 embryos in capsules 54 $\times$ 30 mm. The embryo being 90 mm. long, the body 4 mm. wide, the head like a bird's, almost spherical and about 6 mm. in diameter, the eye 3 mm. in diameter, pigmented. The markings on these two adults are very clear, there being about 73 dorsal spots, decidedly and clearly outlined with very dark brown, the center light walnut color but darker than the brown body color. Length 5′9″ and 6′ respectively. Another specimen from near the City of Río Piedras 2′10½″ long is a light tan color. In distinction to all other specimens seen the dorsal spots, 78 in number, are lighter instead of darker than the body color, with a suggestion of a darker border.

Hence, light instead of dark spots are counted on this specimen. A postocular dark line is prominent in this specimen. The fifth specimen, 370 mm. long, is one of a litter of 18, of which more may have escaped un-noticed, born in captivity at Río Piedras, in the possession of Mrs. T. J. Haydon. She had no success in feeding the young which all escaped or starved. It is impossible to count accurately the dark spots on this specimen because they are so broken up, but there appear to be about 70. One of her adults constricted a guinea pig but would not swallow it.

This boa appears to be entirely inoffensive and strikes only when hurt. On the defensive, it frequently ties itself into a ball with the head entirely hidden within the folds of the body. It hisses loudly and can strike with open mouth about one half the length of the body from a gathered position. It does not "coil".

I have measured several skins and several poorly mounted and alcoholic specimens and find none over 6′6″ long, although stories persist of larger specimens.

This snake is partly arboreal, being frequently found in trees. When disturbed, it descends and enters a hole at the base of the tree or makes for rocky places. It is apparently a nocturnal feeder but basks in the early sun before retiring to its lair. The lairs may be distinguished by the strong odor.

Amaral (1) has synonymized this species with *E. subflavus* Stejneger. Stull (2) makes the following remarks: "Doctor Amaral has obviously treated the South American members of this group, with which he is thoroughly familiar and of which he has examined large series of specimens, in a manner quite different from his handling of the West Indian forms, which are almost entirely unrepresented in South American Museums. These species with which he is familiar, as well as those known only from the literature, are subjected to the most casual, and in most cases, ill-advised synonymizing. . . . ."

It seems reasonable to maintain this isolated form as a distinct species until large series are available for comparison. I am personally convinced that the species is distinct.

Fray Inigo Abbad y Lasierra, 1788 tells a "snake story" on this species which for its audacity of conception deserves repeating. He says in substance that this snake inhabits houses and hunts rats at

NOTE: Mrs. Haydon has found that the boas readily eat white rats although they constrict and kill more than they eat. It is interesting to consider what their natural food may have been before the relatively recent introduction of the rat.

night. The snake fastens its head to the floor and raising its body in the air uses it as a flail to slay the rats.

Epicrates monensis Zenneck.

This species is admirably described by Stejneger in "The Herpetology of Porto Rico" from 5 specimens in the Hamburg Museum.

There is one specimen in the Field Museum.

My three specimens, all young, 390, 800 and 810 mm. in total length respectively, agree with Stejneger's description, except in the following: scale rows at mid-body 40, 44, 46, whereas he gives 43 as the maximum; subcaudals 74, 75, 87, whereas his minimum is 79 and maximum 82; supralabials 12–13, 13–14, 14–14, whereas he gives 11–13, 13–13, 13–13, 13–13, 13–13. These amplitudes tend to show slightly greater differences from *E. fordii* than appear in existing descriptions.

The species is rare in collections and practically unknown to the inhabitants of Mona Island. The last recorded specimen, before mine, was taken in 1892.

There have been attempts made to synonymize this species with *E. fordii*, all of which have been rebutted. The last is Amaral (1) who is rebutted by Stull (2) as follows: "The form *Epicrates monensis* Zenneck is synonymized with *E. fordii* (Gunther), although it can be distinguished from the latter not only by its coloration, particularly the considerably smaller number of dorsal spots, but also by apparently constant differences in the numbers of scale rows, ventrals, and caudals. . . . ."

(1) Amaral, A. do, Valor Systematico de Varias Formas de Ophidios Neotropicos. Mem. Inst. Butantan, IV, pp. 1–68, 1929. . . . . ., Lista Remissiva dos Ophidios do Brasil. *Ibid.*, IV, pp. 70–125. . . . . . ., Lista Remissiva dos Ophidios da Regiao Neotropica. *Ibid.*, IV, pp. 126–271.

(2) Stull, Olive Griffith, Corrections to Some Recent Papers on Neotropical Snakes. Bul. Antivenin Inst. of Am. V, No. 2, pp. 39–41, Sept. 1931.

Explanation of Plate XXXVIII

Fig. 1. *Epicrates monensis,* young.
Fig. 2. *Epicrates inornatus,* young.

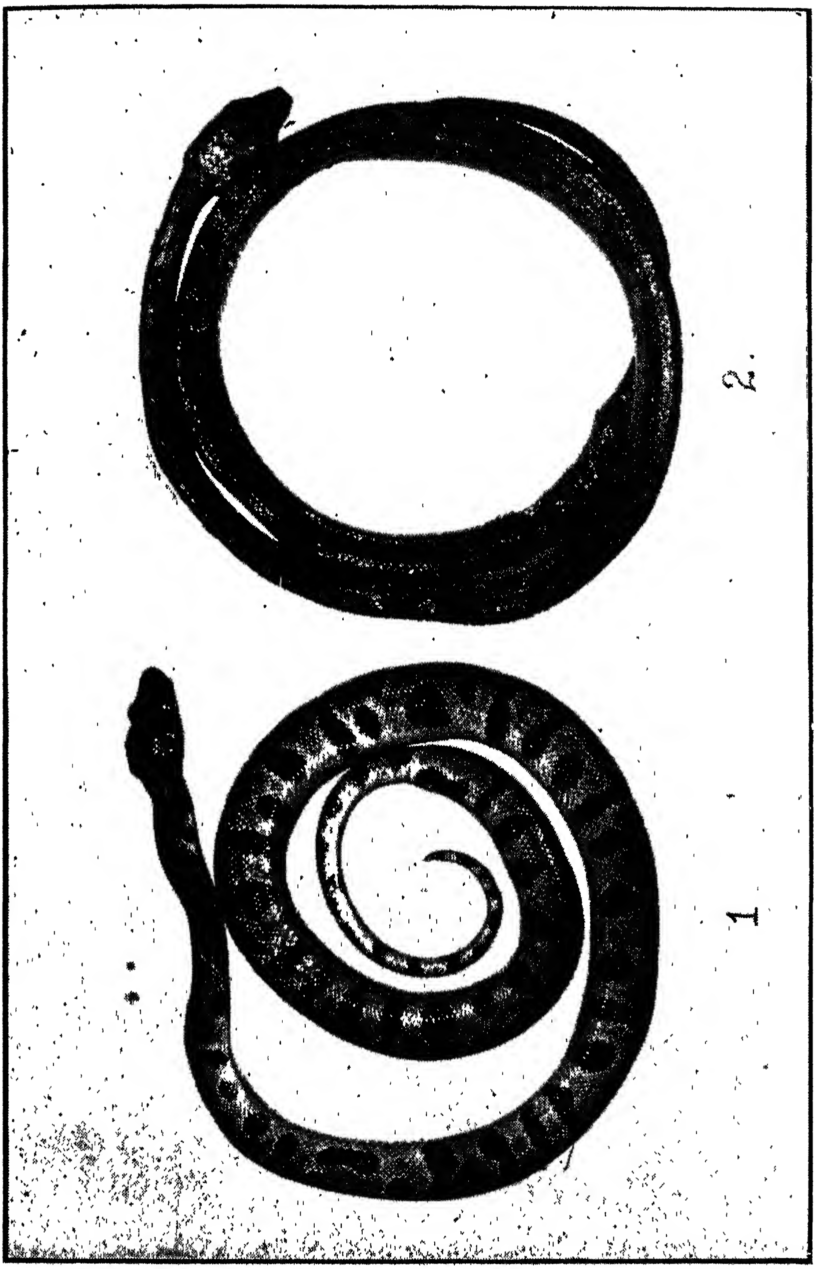

2.
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PLATE XXXIX

PLATE XL

PLATE XLI

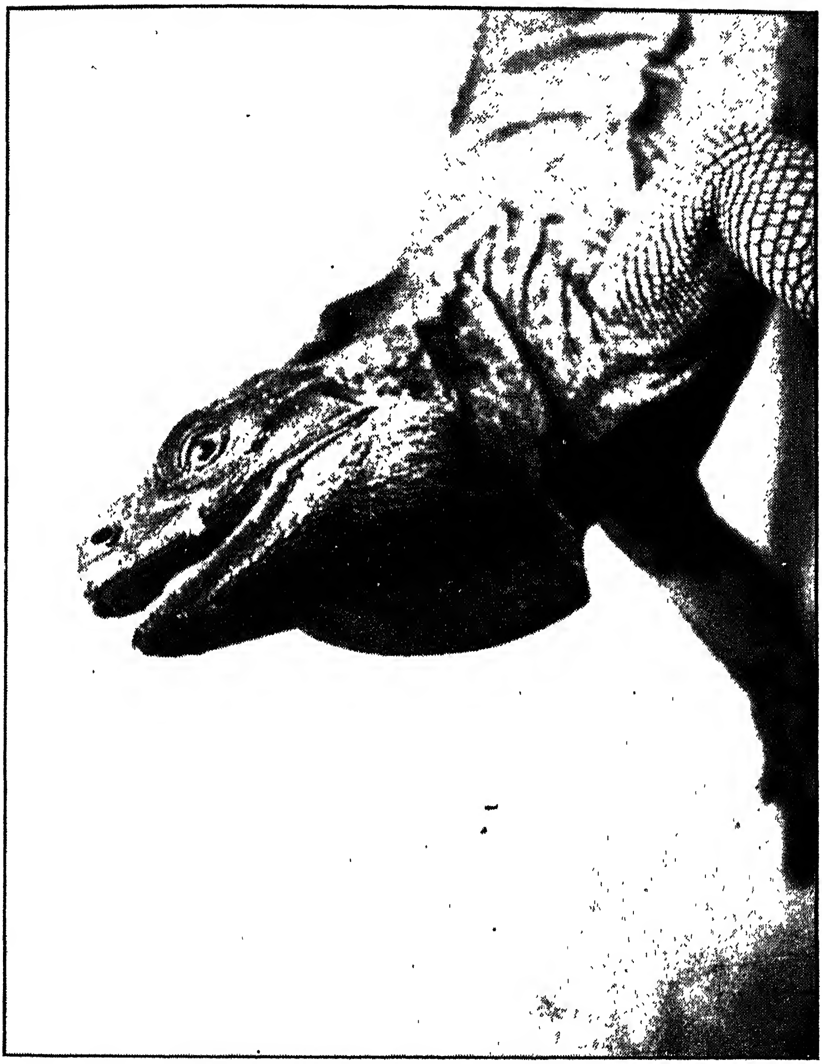

PLATE XLII

THE HERPETOLOGY OF ST JOHN AND ADJACENT KEYS, U. S. VIRGIN ISLANDS

CHAPMAN GRANT, *Major, U. S. Army.*

The arid appearing little Island of St. John lies east of St. Thomas. There is no industry and practically no cultivation except where the scattered negro population tends patches of truck. Mountain trails connect the ruined Dutch manor houses, which flourished in the days of rum and slavery. Schools are plentiful and well attended. Cattle, horses and mongoose are much in evidence. The last has practically exterminated land turtles, ground lizards and snakes.

The principal incentive to visiting St. John, from April 13–17, 1932, was to try to enlarge the herpetological check list which Barbour limits to five species in "Zoologica", Vol. XI, No. 4, 1930. It is easy enough to assume what species probably occur on an Island, but there is greater satisfaction in actually collecting the specimens.

Barbour lists—1. *Ameiva exsul;* 2. *Amphisbaena fenestrata;* 3. *Mabouia sloanii;* 4. *Alsophis antillensis,* and 5. *Dromicus exiguus* only. Of these, *M. sloanii* should undoubtedly read *M. semitaeniatus.* I believe the former is confined to P. R. The latter has probably reached the verge of extermination on St. John, as I saw no specimens and the natives did not recognize a sample shown them from Culebra. They say that snakes are very rarely seen. *Ameiva* seems to be restricted to the neighborhood of the settlement at Cruz Bay, where the mongoose is kept off by the dogs.

The following is probably the latest and most complete list from this area:

1. *Eleutherodactylus antillensis,* (Reinhardt & Lutken). Numerous under banana sheaths, sometimes in groups of eight or more.

Occasional specimens were found in the axils of *bromeliads.* The black loreal region and bright red eyes were prominent. The back is colored terra-cotta, tan, pink or rarely gray. The voice did not seem to differ greatly from the Puerto Rico specimens.

Specimens taken 72

2. *Eleutherodactylus cochranae* sp. nov.

It is described elsewhere in this number. They were found ex-

clusively in the axils of *bromeliads*, together with a few *E. antillensis*. The voice was not heard.

Specimens taken 210

3. *Leptodactylus albilabris* (Gunther).

Plentiful under rocks in the muddy ponds along dry stream beds. They have striking differences from their Puerto Rican counterparts but closely resemble the St. Thomas topotypes, of which I took 7 specimens. It would appear that the P. R. species is different. The St. John species has the upper surface black, the throat heavily marked with black and the snout developed for burrowing, whereas the P. R. form is diversely colored above, white underneath. Many froth nests were found containing eggs and larvae.

Specimens taken 73

4. *Hemidactylus mabouia* (Moreau de Jonnes).

Found in frame buildings and under living banana sheaths. In this it shows a different habitat from *H. brookii* of P. R., which resorts to mortar or stone buildings. Known as "Wood slaves" to the natives.

Specimens taken 21

5. *Sphaerodactylus macrolepis* Gunther

These agree with specimens from St. Croix and Water Island, St. Thomas. The male has a gray body and "Target" pattern head. No red-head males seen, which further strengthens the validity of *S. danforthi*, of Culebra and Vieques. Numerous in favored places.

Specimens taken 22

6. *Anolis cristatellus* Dumeril & Bibron

Numerous and showed no variation from those of St. Thomas, except that on Stephen Key the tail crest was extremely high. None of the highly patterned females was seen as on Puerto Rico. I believe two species are found together on Puerto Rico and are grouped as one.

Specimens taken 16

7. *Anolis pulchellus* Dumeril & Bibron

Not numerous. The fan does not have the crimson center seen on the Puerto Rico specimens.

Specimens taken 24

8. *Anolis stratulus.* Cope

Uncommon. Found from the mangroves at sea level to the hill tops. The fan is of a deeper yellow than on Puerto Rico.

Specimens taken ------------------------------------ 23

9. *Ameiva exsul.* Cope

This species is listed by Barbour. Numerous near the buildings at Cruz Bay where the dogs keep the mongoose away. No large specimens seen. Where the mongoose is numerous, large *Ameivas* are seldom seen. The natives say the "ground lizard" is found nowhere else on the island.

Specimens taken ------------------------------------ 19

10. *Mabouia semitaeniatus.* Wiegmann.

Not seen. Probably near extinction. This species is doubtless what occurred here, but is listed by Barbour as *M. sloanii,* which I believe occurs only on Puerto Rico. The natives did not recognize pictures of this species.

11. *Amphisbaena fenestrata.* Cope.

Not seen. Listed by Barbour. Doubtless numerous but there is so little cultivation that opportunities for taking it are few.

12. *Typhlops jamaicensis* (Shaw)

Two specimens sent me by Mr. B. E. Bauman may be referred to the above species pending a revision of the material from this area.

Specimens taken ------------------------------------ 2

13. *Alsophis antillensis* (Schlegel)

Probably extinct on St. John. Two specimens taken on Dog Island. Said on good authority to occur on Lovango and Congo Keys.

Specimens taken (Dog Island) ------------------------ 2

14. *Dromicus exiguus.* Cope.

Not seen. Listed by Barbour. This is probably the species that is still occasionally seen by the natives. Probably occurs on the outlying keys as well.

15. *Testudo tabulata.*

Still occurs feral on Lovango Key and Water Island. There is excellent authority for including this species which was omitted by later writers. To be treated in another paper.

Specimens taken (Water Island) ---------------------- 3

A group of three islets lies between St. Thomas and St. John, known from east to west as Dog Island, Little St. James and St. James.

Dog Island is the smallest, is treeless and absolutely carpeted with cactus, bearing the finest exhibit of *Cactus intortus* I have ever seen. Specimens taken:

1. *Anolis cristatellus* ---------- 2
2. *Alsophis antillensis* ---------- 2

Little St. James is much larger, has a few thickets and small trees and plenty of cactus and thorns. Specimens taken:

1. *Sphaerodactylus macrolepis* ---------- 2
2. *Ameiva exsul* ---------- 2
3. *Anolis cristatellus* ---------- 3
4. *Anolis pulchellus* ---------- 2

Northwest of St. John lie two narrow keys, Congo and Lovango, parallel and separated by a narrow channel. The former is a steep mass of diorite covered with trees and cactus. The latter is earth covered, grass grown and practically treeless.

Congo Key:

1. *Sphaerodactylus macrolepis* ---------- 6
2. *Anolis cristatellus* ---------- 1
3. *Anolis stratulus* ---------- 3

Lovango Key:

1. *Ameiva exsul* ---------- 3
2. *Anolis cristatellus* ---------- 4
3. *Anolis pulchellus* ---------- 1

Excellent authority points to the occurrence of *Testudo tabulata* on Lovango and *Alsophis* on both keys.

A GENUS OF GECKO NEW TO THE GREATER ANTILLES

CHAPMAN GRANT, *Major, U. S. Army.*

The only mention of the genus *Phyllodactylus* in the West Indies is in Barbour's List of Antillean Reptiles and Amphibians, 1930, Page 82. "*Phylodactylus spatulatus* Cope. Collected years ago in Barbados, about 1861, in fact, by Dr. Theodore Gill. I have no recent information as to its status."

The January, 1932, number of this Bulletin contains a joint article on the herpetology of Caja de Muertos Island in which the writer and Cornelius Roosevelt report the capture of two specimens of *Phyllodactylus spatulatus* Cope.

The identification was made by comparison with some poor specimens kindly loaned for the purpose by the National Museum. The specimens appeared to differ somewhat, but no better comparisons seemed feasible in the time available.

On December 26, 1931, the writer was collecting on a hilltop near Parguera in southwest Puerto Rico. The third and largest specimen was collected from under a small dry log.

The three specimens were taken to the American Museum where, although no specimens were available for comparison, identification was made as closely as possible from a book as *P. pulcher,* Gray.

The type specimen is in the British Museum. Type locality, tropical America.

It now remains for the academic scientist to explain the presence of this little waif in Puerto Rico in terms calculated to quiet further questioning. It may be a "flotsam-jetsam arrival" or have arrived "fortuitously through nonhuman agencies", or across a "land bridge". Personally I believe that the following quotation should amply account for it. "It must be recognized that evolution in the direction of habitat restriction may strictly parallel an evolution in which the primitive forms become peripheral by retreat in space". What more could be said.

Some measurements of the three specimens:

	1	2	3	
Snout to vent	28.	41.	45.	mm.
Snout to ear	9.	12.5	13.5	mm.
Vent to tail tip	---	----	53.	mm.

There is no femoral scale differentiation; consequently the three specimens are probably females.

A description of the third and largest specimen follows:

Phyllodactylus pulcher.

Diagnosis: A gecko of moderate size, the digits expanded at the ends into a pair of large lamellae, between which a small claw protrudes; 20 rows of large dorsal tubercles, keeled, closely set; no tubercles on tail; color brown, transversely striped with eight light bands outlined in dark brown, nape to pelvis; seven light rings on tail; rudimentary eyelids provided with about six short black spines posteriorly.

Habitat: Caja de Muertos Island and Southwest Puerto Rico; "Tropical America."

Squamation: Rostral broader than high, squarish, slightly creased medially above, higher than labials, narrower than mental, in contact with two supranasals; nostril at point of contact of rostral, supranasal and first supralabial followed by two postnasals; six supralabials, fifth ending just posterior to pupil, followed by small scales; top of head covered with large roughly hexagonal tubercles, about 13 between eyelids; posteriorly on head tubercles interpersed with granules; eye slightly nearer to snout than to ear; its diameter being 1½ its distance from snout, rudimentary eyelid furnished with six or more short sharp black spines posteriorly; ear opening elongate, oblique, unarmed; mental pentagonal, wider than rostral, 4 large infralabials followed by several small ones, two chin shields, irregularly pentagonal, their anterior angle fitting into corner between mental and part of first infralabial, broadly in contact with each other on the median line, followed by two rows of about 6 somewhat enlarged flat scales, then by small flat scales to neck; neck to vent and lower surface of legs covered by larger smooth, imbricate cycloid scales, about 22 across center of body, about 50 neck to vent; upper surface of body, flanks and legs covered by large keeled tubercles, the two median rows elongated, the rest nearly round, ten rows across center of back, 33 rows occiput to base of tail; tubercles separated by about one granule front to rear and two laterally; fingers and toes all with about 10 rows of transverse lamellae the terminal few in pairs; terminally two large square lamellae, between which protrudes a small claw; dorsal aspect of digits resembles a lobster telson; tail cylindrical, covered above and laterally with large imbricate scales irregularly interspersed with small similar

scales, underside one row of transverse scales, all scales pitted over their entire surface.

Color and markings: Upper surface brown and light; a dark brown diamond with light center on snout; head marbled brown and light; dark transocular stripe, snout to ear; 11 alternate light and dark transverse bands, nape to base of tail, edged with darker brown; tail similarly ringed with about 15 alternate rings; underside, light, finely specked with brown, several specks on each scale except under jaws where each scale bears one brown speck. Young more vividly colored than larger specimens.

Pupil vertical with wavy edges. Undoubtedly a species of nocturnal habits.

Reference: Gray, Spicil. Zool., Vol. 1, p. 3, pl. 3, Fig. 1.

Explanation of Plate XXXIX

Phyllodactylus pulcher, young.

HERPETOLOGY OF TORTOLA; NOTES ON ANEGADA AND VIRGIN GORDA, BRITISH VIRGIN ISLANDS

CHAPMAN GRANT, Major U. S. Army

There are several theories advanced to explain the distribution of the flora and fauna of the West Indies. This is a problem for the Biologist, Botanist and Geologist to work out together. The superficial appearances are that land connections existed with North America via the Bahamas; with Central America; with South America. How extensive these connections were in both time and space is conjecture. For that matter, the whole Caribbean Sea may have been land at one time. The solution of the problem can be helped by knowledge of the species of plants and animals that inhabit the islands. With this end in view, the writer visited Tortola from August 10th to 16th, 1932. The results were gratifying.

The most complete and accurate compilation of the herpetological fauna of this area is Barbour's "A List of Antillean Reptiles and Amphibians" Zoological, XI, No. 4, 1930. Therein are listed eight species from Tortola. The writer had the satisfaction of adding nine species to this list and one to Barbour's list of seven from Anegada. He also added four *Cactaceae* to Dr. Britton's list from Tortola, and added specimens and information on the herpetology of St. Thomas and St. John. The last was previously described in this Journal, adding ten to Barbour's five listed species. The present trip produced another from St. John, making the total from that island sixteen. The writer's stay on Tortola was made pleasant and profitable by the hospitality of Commissioner Clarkson and the enthusiasm of Mr. Fonseca.

The following annotated list is the result of the trip:

Bufo turpis Barbour

Found only on Virgin Gorda. The type, and seven specimens taken by Dr. Danforth of Mayagüez in 1931 are the only specimens known.

Eleutherodactylus portoricensis Schmidt

Known locally as "bo-peep". Not listed by Barbour.

The discovery of this species on Tortola is of especial interest on account of the light it throws on frogs of the same name in Puerto Rico. The series of 44 from Tortola shows very little variation in

color, pattern, size or voice. This strengthens the conviction that two or more species are included under this name in Puerto Rico. The Tortola specimens have a light gray back, white belly, no pattern or marking other than a dark canthus rostralis and occasionally orange on covered surface of thighs. The voice has no variations as on Puerto Rico. Their song is heard everywhere from afternoon throughout the night. They seem greatly to outnumber *E. antillensis*, judging from the volume of sound, as compared to the relatively uncommon "click-click-click" of the latter.

Specimens taken: Tortola, 44.

Late one evening while tacking up the channel between St. John and Thatch Island of Tortola, the "bo-peep" of *E. portoricensis* could be heard each time that the shores of St. John were neared. This adds a new record to the herpetological list of St. John.

Eleutherodactylus antillensis (Reinhard & Lütken)

No local name. This species is confounded by the natives with *E. portoricensis* as a "bo-peep". Listed by Barbour. Uncommon, not found on adjacent islets. The voice, a "click-click-click" is identical to the Puerto Rico and St. John specimens. Color much darker; no terracotta or gray backs seen; one specimen had a violet-pink back. The characteristic red eye, black canthus rostralis and reticulated thighs present. The voice is seldom heard among the babel of "bo-peep" of *E. portoricensis*.

Specimens taken: Tortola, 6.

NOTE: The voice of another species, resembling that of *E. gryllus* was heard, but the frogs were not located.

Leptodactylus albilabris (Günther)

Known locally as "water frog". Listed by Barbour. Not found on any surrounding islets. Numerous; breeding. Voice same as elsewhere. Individuals average darker with more spotted throat than on Puerto Rico but much lighter than the St. Thomas and St. John forms which have a much more spotted throat. No large specimens seen as on Puerto Rico.

This frog has a throaty chuckling trill, apparently used during uncertainty as to threatening danger. It follows or precedes the song which is "creep", repeated many times. The "pink" mentioned by Stejneger is really a single note, often repeated and sounding like a sharp instrument being tapped on metal. Individuals seem to give this in different keys. There are other little notes that sound almost like a conversation.

Specimens taken: Tortola, 50.

Hemidactylus mabouia (Moreau de Jonnés)

Locally shares the name of "wood slave" with the Giant *Anolis*. Listed by Barbour. This is the real *H. mabouia* and not the *H. brookii* Gray of Puerto Rico that long masqueraded under this name. None seen on buildings at night. Rare.

Specimens taken; Peter Island, 2. A small *Alsophis antillensis* taken at the same time and place disgorged an adult *H. mabouia.*

Sphaerodactylus macrolepsis Günther

Locally known as "cotton ginner". Listed by Barbour. Common. Found on most of the outlying islets. No red-head males taken or seen. This further strengthens the position of *S. danforthi,* which is similar, but has a proportion of red-head males. It has none of the characteristics of the distinct *S. grandisquamis* Stejneger of Puerto Rico.

Specimens taken: Tortola, 145; Peter Island, 1; Buck Island 13. Seen on Guana Island.

Iguana iguana

Known locally as "guana". Not listed by Barbour. Guana Island derives its name from this species. It is not used for food by the natives. Known only from Guana Island and Peter Island of the British Virgins. No specimens taken but one seen on Peter Island.

A previous report was made of taking iguanas on Water Island, St. Thomas. On this trip a specimen was taken on Hassell Island, St. Thomas, and one was seen in a grape arbor in the City of St. Thomas. They are said to be numerous at Botany Bay. An *Alsophis antillensis* taken on the beach of Water Island had eaten three baby iguanas, probably recently hatched. These were bright green, tail ringed brown, green and blue. The most noticeable mark is a white stripe from neck to elbow. Snout to vent 75 mm.; tail 190 mm. A story prevalent among the natives, and seemingly true, is that the iguana will take refuge by diving into the sea where it will cling to the rocks. The eggs, to the number of 30 or more, are buried in beach sand. The tracks and mark of the dragging tail are a common sight on the beaches. Barbour lists *Iguana rhinolopha* Wiegmann and *Iguana delicatissima* Laurenti as the only species of this genus occurring in the West Indies.

I. rhinolopha has tubercles on the snout and *I. delicatissima* has 19–20 femoral pores. The Virgin Islands specimens have smooth

snouts and only 13–15 pores, placing them with *I. iguana,* which has 12–18 pores.

Anolis cuvieri Merrem.

Possibly known locally as "wood slave". Listed by Barbour. None seen. Inasmuch as a distinct species *A. roosevelti* Grant is found on Culebra, the occurrence of this species on Tortola is doubtful. A giant *Anolis* on Tortola would probably be a distinct species.

Anolis cristatellus Duméril & Bibron

Known locally as "man lizard", "doctor lizard" and "common lizard". Listed by Barbour. Very numerous. The green and red of the throat fan is constant here and not subject to the great variation seen on Puerto Rico. The tail fin on males from some of the islets is extremely high. One specimen from Guana Island has the fin rays as long as snout to posterior part of orbit, or 3½ times as high as tail is deep at that point, or 15 mm. high. This is the highest fin I have ever seen.

Specimens taken: Tortola, 63; Peter Island, 10; Guana Island, 2; Fallen Jerusalem, 5; Anegada, 15. Seen on all small islets visited.

Anolis pulchellus Duméril & Bibron

Known locally as "snake lizard". Listed by Barbour. Numerous in grassy places. Apparently identical to the Puerto Rico specimens, except that on Puerto Rico this species is unique in having a crimson center to the red fan.

Specimens taken: Tortola 23; Peter Island 2; Guana Island 1.

Anolis stratulus Cope

Known locally as "salmon lizard". Listed by Barbour. Very numerous. Average much lighter colored with deeper orange fan than the Puerto Rico specimens; hence the dorsal marks are much more pronounced. When threatening fight, the males protrude a blood red tongue which at other times is pink.

Specimens taken: Tortola, 40; Peter Island, 2; Guana Island, 1. Seen on Fallen Jerusalem.

Cyclura pinguis Barbour

Known locally as "guana". Listed by Barbour as "excessively rare if not now gone". Now reported numerous on Anegada. Color notes from living specimens: Tongue and lining of mouth pink pupil vertical, iris dark brown but small, leaving the white of the

eye so prominent as to appear to be a white iris. Above: face, sides of head, between eyes and lower jaw bulbs olive; strip across nostrils including the turtle-like rostral, postocular bulbs and "cape" reaching to shoulders, dark brown reticulated with black; thence to base of tail black reticulation more prominent, forming three black chevrons, points at crest; tail dull turquoise blue reticulated with black on basal third, thence brown; caudal crest turquoise. Below: dewlap and chest mahogany, fading to gray on belly and tail; occasional dark scales form patterns on undersides of legs and sides of body and especially on posterior aspect of thighs. The scales of back and sides are soft and granular, giving a leathery appearance and texture.

Specimens taken: Anegada, 2 young males. Snout to tip of tail 1,075 mm.; snout to vent 410 mm. These are about two-thirds adult length and about one-third bulk.

Ameiva exsul Cope

Known locally as "ground lizard". Not listed by Barbour. Common in flat or sandy places on Tortola and adjacent keys. On Tortola this species is dark, loses its dorsal stripes early in life and does not have the reddish or lavender chin frequently seen elsewhere. It coincides exactly with the species on Puerto Rico in femoral pore count. There is a wider variation in anal plates, but not to a significant degree. Altogether, it is the least attractive representative of the species in the area. No large specimens were seen, probably due to the mongoose. Two large specimens from Buck Island were colored in the same drab fashion, but Guana Island, Peter Island and Anegada produced large, highly colored specimens, with prominent dorso-lateral stripes, reminiscent of similar ones on Culebra. One Peter Island specimen had particularly noticeable turquoise blue on the sides of head and neck. A color combination new to me. The bright colored specimens had a lower pore count, but there were not enough taken to determine whether this was of any significance.

Specimens taken: Tortola, 34; Peter Island, 4; Buck Island, 2; Guana Island, 2; Anegada, 2. The specimens from Anegada are a new record from that Island.

Amphisbaena fenestrata Cope

Known locally as "ground worm". Not listed by Barbour. The specimens taken differ from *A. fenestrata* in having only one temporal scute instead of two, and 16 segments below the lateral line

instead of 14. It may remain in this species pending further comparison. It is difficult to procure as "there is not a plow in Tortola".

Specimens taken: Tortola, 5.

Mabuya semitaeniatus (Wiegmann)

Known locally as "slippery back". Not listed by Barbour. Rare. The one specimen taken on Salt Island does not coincide in color or squamation with a series of 155 specimens from Culebra, Mona and Buck Island, of St. Thomas. It is still further removed from *M. sloanii* (Daudin) of Puerto Rico. It may remain as *M. semitaeniatus* pending comparison with more material.

Specimens taken: Salt Island, 1.

Typhlops richardii Duméril & Bibron

Known locally as "ground snake". Not listed by Barbour. This species has the dark mahogany coloration and small size of *T. rostellatus* Stejneger, but lacks the white chin and tail markings. It is smaller than *T. jamaicensis* (Shaw), lacking the white caudal notch or ring and the light venter.

This species is reestablished pending a study of the material from this area, of which 225 specimens from Vieques, Culebra, Mona, St. John, St. Thomas, Caja de Muertos, Tortola and Puerto Rico are in my collection.

Found under a heap of bagasse at a rum mill, apparently preying upon small life, together with the *Amphisbaena* and the three species of frogs. Shed skins had the appearance of quills, not collapsing like ordinary snake skins.

Specimens taken: Tortola, 32.

Epicrates sp.

Species to be described later.

Known locally as "night snake". Not listed by Barbour. Said to attain five feet or more in length. Inhabits rocky cliffs on Tortola and Guana Island. It was a great surprise to find a boa so far east of the eastern record of this family, *Epicrates inornatus* (Reinhardt) of Puerto Rico, and greatly lessening the gap to Dominica and *Constrictor orophias* (L), the northern limit of the family in the West Indies.

Specimens taken: Tortola, 1.

Alsophis antillensis (Schlegel)

No local name other than "snake". Not listed by Barbour from Tortola. Listed from Virgin Gorda.

This snake varies considerably on the different islets. A specimen from Salt Island being typical of a large series from Culebra. Two from Peter Island are uniquely marked; four scales of the fourth, fifth and sixth rows forming a white spot with a dark border. There is a checkerboard pattern on the neck. The throat of all specimens is straw yellow in life. One specimen from Peter Island disgorged an adult *Hemidactylus mabouia.* A specimen from Water Island, St. Thomas, contained three young *Iguana iguana.* This snake is most readily found at early morning along the beaches. It is seldom met with after 10:00 a. m. Reported very rare on Tortola but said to occur on all the islets around.

Specimens taken: Salt Island, 1; Peter Island, 2.

Dromicus exiguus Cope

No local name for this species which is apparently locally considered to be the young of Alsophis. Not listed by Barbour. Frequently met with by persons gardening or cultivating. Two specimens reported to have been found "torpid" in the "Winter" in the cracks of an old wall which was being demolished. Apparently identical to St. Thomas specimens.

Specimens taken: Tortola, 2.

Testudo tabulata

Known locally as "land turtle". Not listed by Barbour. According to inhabitants, occasionally met with in the "bush" on Tortola but "none seen within two years". The certainty with which natives state that none occurs on any of the outlying islets, lends strength to their statements of its occurrence on Tortola. Another check is the immediate answer that there are no fresh water turtles.

Excluding *Testudo tabulata,* the above list adds 9 species to Tortola and its adjacent islets that are new to Barbour's list of 8 and gives the island a population of 17 species.

The most important finds were the discovery of the boa and that *E. portoricensis* is not confined to Puerto Rico.

The *cactaceae* listed by Britton from Tortola are: *Cephalocereus Royeni; Hylocereus undatus; Selenicereus grandiflorus; Cactus intortus; Neomammilaria nivosa; Opuntia repens; O. antillana; O.*

rubescens. Of these, *H. undatus* was not found, but *Hylocereus trigonus* (Haw.) Stafford was found to be abundant and is added to the flora of the island together with *Opuntia Dillenii* (Ker-Gawl) Haw.; *Opuntia triacantha* (Willd.) Sweet; *Lemaireocereus hystrix* (Haw.) Britton & Rose, all of which are abundant.

Explanation of Plates

Plate XL. *Cyclura pinguis*. Note the whites of the eyes, large nostrils and muscular bulb of lower jaw.

Plate XLI. Same; note throat fan and absence of rostral spines.

Plate XLII. Same; note lateral fold, smooth snout and throat fan.

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THE CRANE-FLIES OF PUERTO RICO

(Diptera)

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INTRODUCTION

At the suggestion of my friend, Dr. M. D. Leonard, I have prepared the following brief account of the Tipulidae of Puerto Rico. Although much has been done in the collection of specimens, still further work will unquestionably add materially to the subjoined record. The following is the plan of the present report:

I. Historical Account.
II. Distribution of Genera and Subgenera in the Greater Antilles.
III. Keys to the Subfamilies, Tribes, Subtribes, Genera and Subgenera of Tipulidae known from the Greater Antilles.
IV. A record of the Tipulidae known from Puerto Rico, with keys and brief diagnoses of the species.
V. A list of the Tipulidae known from the Greater Antilles.

A very few species and subspecies, not only from Puerto Rico, but from other islands, are described at this time in order to complete the data. All types of these novelties are preserved in my collection.

During the progress of this survey of Neotropical Tipulidae invaluable co-operation has been received from many persons and institutions. I here wish to acknowledge the kindly help of the following, who have been of especial service in adding to our fragmentary knowledge of the Tipulidae of the West Indian Islands. Cuba: Julián Acuña, Joseph Bequaert, S. C. Bruner, J. G. Myers, A. Otero, G. C. Rowe, P. D. Sanders. Hispaniola: H. L. Dozier, J. G. Myers. Jamaica: G. C. Crampton, C. C. Gowdey, J. G. Myers. Puerto Rico: Charles Bates, W. A. Hoffman, W. T. M. Forbes, M. D. Leonard.

In addition to the above, the collections of the American Museum, with additional material secured by Grossbeck in Jamaica, and by Lutz, H. E. Crampton, Mutchler and others in Jamaica and Puerto

Rico; the British Museum material, through the kindly interest of Dr. Fred W. Edwards; and the United States National Museum, with early specimens taken by Busck, Schwarz and Richmond, should be mentioned.

The rich Antillean collections in various American institutions are due almost entirely to the efforts of the above men, here gratefully acknowledged. From the following account, it will be seen that the collections made by Messrs. Acuña, Bruner, G. C. Crampton, Gowdey, Hoffman, Leonard and Myers are by far the largest and most important.

I wish to thank my old-time friend and co-worker on the Tipulidae, Dr. Mortimer D. Leonard, for much kindly help and advice at frequent periods in the past quarter century.

I. Historical Account

The first Tipulidae ever taken in Puerto Rico would appear to be those now preserved in the Berlin Museum, collected previously to 1850 by Moritz, and described by Loew in 1851 (*Limonia (Geranomyia) rufescens* and *Toxorhina fragilis*) and by Osten Sacken in 1887 (*Brachypremna unicolor* and *Helius albitarsis*). Still later, Dr. Juan Gundlach collected in various parts of the island, his material forming the basis for the important paper by von Röder in 1885 (*Hexatoma trifasciata* and *Megistocera longipennis* Macquart).

Subsequent to the Spanish-American war and the transference of Puerto Rico to the United States, various officials from the United States National Museum (August Busck in 1899, Charles W. Richmond in 1900) made collections of insects in Puerto Rico, these including a few species of Tipulidae (*Dolichopeza portoricensis*, *Trentepohlia niveitarsis*). During the period of the World War, an expedition under the joint auspices of the New York Academy of Sciences and the American Museum of Natural History made extensive collections in Puerto Rico and other islands of the Antilles, the insects being taken chiefly by Messrs. H. E. Crampton, Lutz and Mutchler, and being discussed in detail in the comprehensive report by Curran (Scientific survey of Puerto Rico and the Virgin Islands, vol. 11, part 1. Insects, Diptera or two-winged Flies, pp. 1–118, 39 figs.; 1928). This records a total of 11 species of Tipulidae. During this same general period, a few species of Tipulidae were collected by Mr. R. H. Van Zwaluwenburg and were sent by him to the United States National Museum (including *Hexatoma ocellifera*). Wolcott (Insectæ Portoricensis. Journ. Dept. Agr. Puerto Rico, vol.

7:1–313; 1923) recorded 9 species of Tipulidae from the island. In more recent years the present writer has described a number of additional species of Tipulidae, these being recorded in the present report. The total number of species of this family now known from Puerto Rico is 31, to which number many additions will surely be made as a result of future collecting. The mountainous region embraced in the Luquillo National Forest, culminating in El Yunque, will surely yield additional species, some of which will be endemic. This particular part of the island is of unusual interest, several species apparently being restricted to this region.

II. Distribution of Genera and Subgenera in the Greater Antilles

The accompanying table will show the present distribution of the genera and subgenera of crane-flies in the islands.

Genus and Subgenus	Cuba	Hispaniola	Jamaica	Puerto Rico
Tipulinae				
Nephrotoma	*	*	—	—
Tipula	*	—	*	—
Dolichopeza – Megistomastix	*	—	—	*
Brachypremna	*	*	—	*
Megistocera	*	*	—	*
Limoniinae				
Limonia–Limonia	*	—	*	*
— *Discobola*	*	—	*	—
— *Neolimnobia*	*	—	*	*
— *Dicranomyia*	*	*	*	*
— *Rhipidia*	*	*	*	*
— *Geranomyia*	*	*	*	*
Helius–Helius	*	—	*	*
Orimarga–Orimarga	*	—	—	—
— *Diotrepha*	*	—	*	—
Epiphragma–Epiphragma	*	*	—	—
Polymera–Polymera	*	—	—	*
Shannonomyia	*	—	*	*
Atarba–Atarba	*	—	—	—
Hexatoma–Eriocera	*	*	*	*
Elephantomyia–Elephantomyia	*	*	—	—
Gonomyia–Gonomyia	*	—	—	—
— *Progonomyia*	*	—	*	—
— *Ptilostena*	*	—	—	—
— *Lipophleps*	*	*	*	*
Teucholabis–Teucholabis	*	—	*	—
Trentepohlia–Paramongoma	—	—	*	*
Rhabdomastix–Sacandaga	—	*	*	—
Erioptera–Empeda	—	—	*	—
— *Mesocyphona*	*	—	—	*
Toxorhina–Toxorhina	*	*	—	*

From this list, it will be seen that of the 30 groups, Cuba has 27, Jamaica 17, Puerto Rico 16 and Hispaniola 12. The marked deficiency in the case of the last-named major island is surely a result of collecting rather than an actual condition. The non-occurrence

of such conspicuous elements as *Brachypremna* and *Megistocera* in Jamaica is noteworthy.

Of the above, the sole endemic group is the subgenus *Megistomastix,* known only from two species, one being confined to Puerto Rico, the other to western Cuba. This subgenus finds its near ally in the subgenus *Oropeza* Needham, widely distributed in eastern North America, and must surely have been derived from the north. The two species of *Nephrotoma* (*ferruginea* Fabr., var.) and *Tipula* (*ludoviciana* Alex.) in Cuba are forms that also occur in the south-eastern United States, and have certainly invaded the island from the north. Of the Limoniinae in the islands, *Discobola, Sacandaga, Gonomyia* s.s. and *Ptilostena* are evidently derived from the north.

Megistocera, Brachypremna, Neolimnobia, Rhipidia, Geranomyia, Helius, Orimarga s.s., *Diotrepha, Polymera, Atarba, Progonomyia, Lipophleps, Teucholabis, Trentepohlia, Mesocyphona* and *Toxorhina,* on the other hand, all seem to be derivatives from the south, in all cases either having the greater part of their present distribution in Central or South America, or, in the case of larger groups, having the great majority of the known species, insofar as they exist in the New World, occurring in the Neotropics. The origin of some of the other groups, as *Limonia,* s.s., *Dicranomyia, Eriocera,* and possibly a few others, is uncertain, as the groups in question are virtually cosmopolitan. *Limonia* s.s., however, is evidently still another Neotropical element, insofar as it is represented in the Antilles by members of the *apicata* group (*basistylata* Alex., *hoffmani* Alex.), members of which have extended their range northward of the islands into Florida. Some of the species of *Dicranomyia* are northern forms that are isolated at higher altitudes on the mountains of Puerto Rico and Hispaniola (as *divisa* Alex.) or else are widespread coastal forms with a vast range in tropical and subtropical America (as *distans* O. S.). The Cuban *reticulata,* however, is a member of a group of characteristic Neotropical species of the subgenus. The 8 species of *Eriocera* in the Greater Antilles form a highly characteristic group that are more nearly related to species in Middle and South America than they are to the more sombre species of the North.

III. Keys to the Subfamilies, Tribes, Subtribes, Genera and Subgenera of Tipulidae Known From the Greater Antilles

1. Terminal segment of maxillary palpus elongate, whiplash-like; nasus usually distinct; antennae usually with 13 segments; wings with Sc_1 usually atrophied; vein Cu_1 constricted at *m-cu,* the latter usually at

or close to fork of $M_3 + _4$ (Figs. 1–3); body-size usually large. (TIPULINAE) 2

Terminal segment of maxillary palpus short; no distinct nasus; antennae usually with 14 or 16 segments; wings with Sc_1 present; vein Cu_1 straight, not constricted at *m-cu*, the latter placed far before the fork of $M_3 + _4$, usually at or close to fork of M (Figs. 4–5, 10–19), in *Orimarga* (Fig. 9) far before the fork of M; body-size small or medium (LIMONIINAE) 6

(TIPULINAE)

2. Legs unsually long and filiform; wings with vein $R_1 + _2$ atrophied and with Sc_2 close to origin of Rs (*Dolichopeza*, Fig. 3); when $R_1 + _2$ is preserved (*Brachypremna*, Fig. 2, *Megistocera*, Fig. 1), vein Sc is very long, Sc_1 reaching C as a distinct element some distance beyond the fork of Rs and cell *2nd A* is very narrow 3

Legs of normal stoutness for the family; wings with $R_1 + _2$ preserved and with Sc of moderate length, Sc_1 being atrophied before the fork of Rs and Sc_2 ending at or before midlength of Rs; cell *2nd A* of normal width 5

3. Antennae 8-segmented; wings with origin of vein M_4 usually opposite or even basad of that of $M_1 + _2$; $R_2 + _3$ angularly bent at near midlength (Fig. 1) MEGISTOCERA Wied.

Antennae with 11 or more segments; wings with origin of vein M_4 distad of that of vein $M_1 + _2$, usually far beyond; $R_2 + _3$ straight or nearly so, not angulated 4

4. Wings with vein $R_1 + _2$ pale, perpendicular to $R_2 + _3$; Rs elongate, strongly arcuated at origin; cells of wing glabrous (Fig. 2) BRACHYPREMNA O. S.

Wings with vein $R_1 + _2$ atrophied; Rs short, transverse, simulating a cross-vein; apical cells with macrotrichia (Fig. 3) DOLICHOPEZA: MEGISTOMASTIX Alex.

5. Wings with Rs short and oblique in position, shorter than *m-cu*; cell M_1 sessile or very short-petiolate; vein M_4 arising opposite or basad of orgin of $M_1 + _2$; body coloration highly polished, orange and yellow NEPHROTOMA Meig.

Wings with Rs elongate, exceeding *m-cu*; cell M_1 petiolate; vein M_4 arising distad of origin of $M_1 + _2$; body-coloration gray pruinose (in regional forms) TIPULA Linn.

(LIMONIINAE)

6. Wings with the free tip of Sc_2 often present; veins R_4 and R_5 fused to margin, only two branches of Rs being present; antennae usually with 14 (Limoniaria) or 16 segments. (Limoniinini) 7

Wings with the free tip of Sc_2 atrophied; veins R_4 and R_5 separate, the former usually transferred to the upper branch, $R_2 + _3$, to form a distinct element $R_2 + _3 + _4$; usually with three branches of Rs present (Figs. 10–12, 14, 17–18); in local fauna, exceptions in *Atarba*, *Elephantomyia* (Fig. 13), *Teucholabis* (Fig. 16), some *Gonomyia* (Fig. 15) and *Toxorhina* (Fig. 19), where R_4 is captured by $R_2 + _3$, as above; antennae usually with 16 segments 15

7. Wings (Fig. 5) with vein R_2 lacking. (Heliaria) ---------- HELIUS St. Farg.
Wings with vein R_2 present ---------- 8
8. Wings with *m-cu* three or more times its own length before the fork of *M* (Fig. 9); antennae 16-segmented. (Orimargaria) ---------- 9
Wings with *m-cu* close to or beyond the fork of *M*, if placed before, the distance not or scarcely exceeding the length of the vein itself (Fig. 4); antennae 14-segmented. (Limoniaria) ---------- 10
9. Wings with three branches of *M* reaching margin, cell M_3 being present; *m-cu* beneath *Rs* ---------- ORIMARGA: ORIMARGA O. S.
Wings (Fig. 9) with two branches of *M* reaching margin, cell M_3 being lacking; *m-cu* far before origin of *Rs* ---------- ORIMARGA: DIOTREPHA O. S.
10. Supernumerary crossveins present in either cell R_3 or *1st A* of wings ---------- 11
No supernumerary crossveins in either of the cells mentioned ---------- 12
11. Wings with *Sc* short, Sc_1 ending opposite or before origin of *Rs*; a supernumerary crossvein in cell R_3 ---------- LIMONIA: NEOLIMNOBIA Alex.
Wings with *Sc* long, ending about opposite the fork of *Rs*; a supernumerary crossvein in cell *1st A*, connecting the Anal veins near their outer ends ---------- LIMONIA: DISCOBOLA O. S.
12. Mouthparts, and especially the labial palpi, lengthened, the rostrum thus formed much longer than the remainder of head and usually about as long as the combined head and thorax ---------- LIMONIA: GERANOMYIA Hal.
Mouthparts, with the labial palpi, not notably lengthened, shorter than remainder of head ---------- 13
13. Antennae of male strongly subpectinate, of female less markedly so ---------- LIMONIA: RHIPIDIA Meig
Antennae simple in both sexes ---------- 14
14. Wings with *Sc* short, Sc_1 ending opposite or before origin of *Rs*. ---------- LIMONIA: DICRANOMYIA Steph.
Wings (Fig. 4) with *Sc* long, Sc_1 ending beyond midlength of *Rs*. ---------- LIMONIA: LIMONIA Meig.
15. Tibial spurs present. (Hexatomini) ---------- 16
Tibial spurs lacking. (Eriopterini) ---------- 22
16. Antennae with not more than 12 segments (Hexatomaria). ---------- HEXATOMA: ERIOCERA Macq.
Antennae with more than 14 segments ---------- 17
17. Wings (Fig. 13) with only two branches of *Rs* present; vein R_2 lacking ---------- 18
Wings (Figs. 10–11, 14) with three branches of *Rs* present; vein R_2 preserved ---------- 19
18. Rostrum elongate, exceeding one-half the length of remainder of body; wing (Fig. 13). (Elephantomyaria) ---------- ELEPHANTOMYIA O. S.
Rostrum short and inconspicuous, not exceeding the remainder of head. (Atarbaria) ---------- ATARBA O. S.
19. Apical cells of wing with macrotrichia. (Limnophilaria) ---------- SHANNONOMYIA Alex., part.
Cells of wing glabrous ---------- 20
20. A supernumerary crossvein in cell *C* of the handsomely patterned wings (Fig. 14). (Epiphragmaria) ---------- EPIPHRAGMA O. S.

No supernumerary crossvein in cell C; wings plain or only sparsely spotted ---------- 21

21. Wings (Fig. 10) with cell *1st* M_2 open by atrophy of m; cell M_1 present; male with elongate nodulose antennae. (Polymeraria) ---------- POLYMERA: POLYMERA Wied.

Wings (Fig. 11) with cell *1st* M_2 closed, in cases where open, cell M_1 lacking; antennae of both sexes short, not nodulose. (Limnophilaria) ---------- SHANNONOMYA Alex., part.

22. Rostrum very long and slender, approximately one-half the entire body or longer; setae of legs profoundly bifid; wings (Fig. 19) with a single branch of Rs reaching margin. (Toxorhinaria) ---------- TOXORHINA: TOXORHINA Lw.

Rostrum short, not exceeding the remainder of head; setae of legs simple; wings with two or three branches of Rs reaching margin (Figs. 15–18) - 23

23. Two branches of Rs reach the wing-margin (Figs. 15–16). (Gonomyaria) 24

Three branches of Rs reach the wing-margin (Figs. 17–18) ---------- 25

24. Wings (Fig. 16) with R_2 present, close to fork of Rs; Sc usually long, Sc_1 ending beyond origin of Rs ---------- TEUCHOLABIS: TEUCHOLABIS O. S.

Wings (Fig. 15) with R_2 lacking; Sc short, Sc_1 ending opposite or before origin of Rs ---------- GONOMYIA: LIPOPHLEPS Bergr.

25. Wings (Fig. 17) with vein R_5 fused with M_{1+2} to form the entire cephalic face of cell *1st* M_2, r-m thus obliterated; only two branches of M reach the margin; vein *2nd A* very short. (Trentepohliaria) ---------- TRENTEPOHLIA: PARAMONGOMA Brun.

Wings (Fig. 18) with vein R_5 entirely distinct from M_{1+2}, being separated by the r-m crossvein; three branches of M reach the margin; vein *2nd A* of normal length ---------- 26

26. Wings with cell R_3 short, vein R_3 being shorter than the petiole of cell R_3 ---------- 27

Wings (Fig. 18) with cell R_3 deep, vein R_3 longer than the petiole of cell R_3, shortest in *Progonomyia* ---------- 30

27. Wings with vein R_2 lacking ---------- 28

Wings with vein R_2 present. (Eriopteraria) ---------- ERIOPTERA: EMPEDA O. S.

28. Wings with Sc long, Sc_1 extending to about opposite or beyond midlength of Rs; m-cu at or beyond the fork of M; trochanters elongate. (Eriopteraria) ---------- RHABDOMASTIX: SACANDAGA Alex.

Wings with Sc short, not extending to beyond midlength of Rs; if Sc is relatively long (*Ptilostena*), m-cu lies more than its own length before the fork of M; trochanters short. (Gonomyaria) ---------- 29

29. Wings with m-cu more than its own length before fork of M ---------- GONOMYIA: PTILOSTENA Bergr.

Wings with m-cu at or very close to fork of M ---------- GONOMYIA: GONOMYIA Meig.

30. Wings with veins R_3 and R_4 divergent, unequal in length, R_3 being about one-half of R_4; cell R_3 at margin some three or four times as wide as cell R_2. (Gonomyaria) ---------- GONOMYIA: PROGONOMYIA Alex.

Wings (Fig. 18) with veins R_3 and R_4 nearly equal in length, or with R_3 exceeding three-fourths the length of R_4, the veins extending generally parallel to one another to the wing-margin; cell R_2 at margin wider than cell R_3. (Eriopteraria) ---------- ERIOPTERA: MESOCYPHONA O. S.

IV. A Record of the Tipulidae Known From Puerto Rico, With Keys and Brief Diagnoses of the Species

Subfamily Tipulinae

Megistocera longipennis (Macq.) (Fig. 1)

1838. *Tipula longipennis* Macq.; Dipt. exot., 1, pt. 1:57, pl. 5, fig. 1.

1885. *Tipula tenuis* van der Wulp; Notes Leyden Mus., 7:7; Tijdsch. voor Ent., 23:85, pl. 4, fig. 7.

Frontal prolongation of head brown, the nasus distinct; palpi black. Antennae 8-segmented, short in both sexes; scape and pedicel yellow, flagellum black; first flagellar segment shorter than the second, the remainder gradually decreasing in length outwardly. Head brownish gray, the anterior vertex and front more yellowish; eyes very large, on dorsum separated by the narrow anterior vertex that is only about one-third wider than the diameter of the scape; on ventral surface of head the eyes are broadly holoptic.

Mesonotal praescutum chiefly covered by four confluent light brown stripes, the lateral pair somewhat darker brown; lateral margins of praescutum broadly buffy. Pleura buffy-yellow, vaguely marked on anepisternum and coxae by grayish brown areas. Legs long and filiform, brown, the tarsi deepening to brownish black. Wings (Fig. 1) whitish subhyaline, highly iridescent; stigma dark brown. Venation: Vein M_4 usually arising opposite or basad of origin of M_{1+2}; R_{2+3} angularly bent at proximal end of stigma. Abdomen dark brown, the tergites variegated sublaterally with obscure yellow areas.

Male.—Length about 11–13 mm.; wing 15–17 mm.

Female.—Length about 14–17 mm.; wing 16–19 mm.

One of the two largest Tipulidae in the Greater Antilles, the other being *Brachypremna unicolor* O. S. The venation readily suffices to distinguish the present fly from all others. The head and thorax of the single American species are nearly glabrous whereas in the males of the two Old World forms, the body is provided with a dense pale vestiture. Furthermore, the antennae of both Old World species are enormously lengthened, whereas the organ is short in both sexes of the present fly.

Ranges from northern Florida, southward through the Antilles and on the mainland into Brazil and Paraguay.

Puerto Rico: Recorded by von Röder (Stett. Ent. Zeitg., 1885: 338, as *Tipula*).

Brachypremna unicolor O. S. (Fig. 2)

1887. *Brachypremna unicolor* O. S.; Berlin. Ent. Zeitschr., 31: 239–240.

1912. *Brachypremna unicolor* Alex.; Journ. N. Y. Ent. Soc., 20: 235–236, pl. 16, fig. c (wing).

Mesonotal praescutum light brown, with narrow, more or less interrupted

blackish stripes, the usual three stripes being represented only by marginal darkenings; each lateral stripe double, the median vitta triple by a dark capillary median line. Pleura pale. Legs with the femora yellow, the tips narrowly dark brown; remainder of legs brown, the tarsi brownish black. Wings (Fig. 2) unusually long and narrow, subhyaline, the small stigma dark brown; apex of wing and vague seams along certain of the longitudinal veins brown. Venation: The species differs from all other members of the genus in having both veins R_{2+3} and R_{4+5} arise directly from the end of Rs, obliterating the basal section of the latter; cell *1st* M_2 unusually short, roughly triangular in outline; *m-cu* in alignment with the basal section of M_{1+2}.

Abdominal tergites dark brown, the bases and lateral portions of the individual segments somewhat paler; sternites pale, with an almost continuous median line of black dashes.

Male.—Length about 12—17 mm.; wing 16—22.5 mm.

Female.—Length about 16—19 mm.; wing 18—21 mm.

This conspicuous crane-fly is widespread throughout the Greater Antilles, elsewhere being recorded only from the island of Grenada, Lesser Antilles.

Puerto Rico: Described from the island, based on three male specimens taken by Moritz. I have no other records from Puerto Rico, although the species is commonly taken in Cuba and Hispaniola.

It might be expected that *Brachypremna dispellens* (Walk.), the commonest and most widely distributed member of the genus, would occur in the Greater Antilles, since it ranges from the Carolinian zone of the eastern United States, southward on the continent to Argentina, occurring on the island of Trinidad but nowhere else in the West Indian islands.

The present fly may be readily told from all other North American members of the genus by the long, very narrow wings that have the peculiar venation above described, and by the unvariegated legs.

Dolichopeza (Megistomastix) portoricensis (Alex.) (Fig. 3)

1912. *Megistomastix portoricensis* Alex.; Psyche, 19: 63–66, pl. 5.
1931. *Dolichopeza* (*Megistomastix*); Alexander, Philippine Journ. Sci., 46: 270.

Antennae (♂) very long, almost twice the length of the entire body. General coloration of body light brown, the thoracic pleura paler. Legs brown. Wings (Fig. 3) light grayish brown, with a darker stigmal area; conspicuous macrotrichia in cells of wing beyond level of cord (indicated in figure by dots).

Male.—Length about 5 mm.; wing 7.5 mm.; antenna about 9.5 mm.

The present fly is the smallest Tipuline species in the island. It is readily told by the apically hairy wings, with a peculiar venation, and by the greatly elongated antennae of the male sex.

Endemic in Puerto Rico. Known only from the mountainous country of the Luquillo National Forest. Type, a ♂, El Yunque, altitude 2800 ft., February 20, 1900 (C. W. Richmond). Type-locality, a ♂ November 18, 1925 (Am. Mus. Nat. Hist., No. F 5113 A).

(Besides the three Tipuline genera above recorded from Puerto Rico, two other genera, *Nephrotoma* and *Tipula*, have been taken elsewhere in the Greater Antilles.)

Subfamily LIMONIINAE

Tribe LIMONIINI

Subtribe Limoniaria

The only included genus in this subtribe is *Limonia* Meigen, which is now held to include approximately a score of subgeneric groups that until comparatively recently were considered to be valid genera (as, for example, *Limonia, Discobola, Dicranomyia, Rhipidia* and *Geranomyia,* in the local fauna). For a detailed discussion of the reasons for relegating these groups to a minor status, a paper by the present writer may be consulted (Alexander, Philippine Journ. Sci., 40: 239–248; 1929).

Subgenus **Limonia** Meig.

Limonia (Limonia) hoffmani Alex. (Figs. 4, 6)

1927. *Limonia hoffmani* Alex.; Journ. N. Y. Ent. Soc., 35: 265–266.

General coloration obscure brownish yellow, the praescutum with three dark brown stripes. Antennae black; flagellar segments oval, with short apical pedicels. Legs dark brown, the tips of the femora narrowly obscure yellow. Wings (Fig. 4) with a faint dusky tinge, the oval stigma darker brown. Male hypopygium (Fig. 6) with the single dististyle elongate, attached near midlength, its outer lobe obtuse, setiferous, the inner lobe a long slender point, gradually narrowed to the acute tip.

Male.—Length about 4.5—6 mm.; wing 4.5—5.5 mm.

Female.—Length about 5—6 mm.; wing 5—5.5 mm.

Endemic in Puerto Rico. Type, a ♂, Luquillo National Forest, May 10–13, 1927 (W. A. Hoffman). 1 ♂, El Yunque, 1800 feet, February 11, 1930 (M. D. Leonard). 1 ♂, Las Cruces, 1300 feet, March 28, 1930 (M. D. Leonard). 1 ♀, Yauco–Lares, in mountains, resting on coffee leaves (Seín and Wolcott).

The closest ally is another Antillean species, *L.* (*L.*) *basistylata* Alex., of Jamaica.

(The subgenus *Discobola* is not found in Puerto Rico. A new species, *Limonia* (*Discobola*) *gowdeyi*, from Cuba and Jamaica, is described later in the present report).

Subgenus **Neolimnobia** Alex.

Limonia (Neolimnobia) diva (Schin.)

1868. *Limnobia diva* Schin.; Novara Reise, Dipt., p. 46.

1928. *Dicranomyia* (*Neolimnobia*) *diva* Alex.; Dept. Sci. and Agr. Jamaica, Ent. Bull. 4. Catalogus Insectorum Jamaicensis, pt. 3: 20–21.

1929. *Limonia* (*Neolimnobia*) *diva* Alex.; Philippine Journ. Sci., 40: 239–244.

Rostrum and palpi black. Antennae chiefly dark brown; incisures of the flagellar segments restrictedly pale. Head velvety-black in front, paler on the posterior genae.

Mesonotal praescutum with the ground-color blackish, the three usual stripes more brownish yellow, the median one becoming blackish on its posterior half; scutellum and median region of scutum yellow pollinose; scutal lobes extensively brownish black on mesal portion; cephalic portion of postnotal mediotergite broadly blackened medially. Pleura chiefly yellow pollinose. Halteres yellow. Femora yellow, handsomely banded with brownish black; fore and middle femora with two brown rings, posterior femora with three such rings; remainder of legs obscure orange. Wings pale yellow, more saturated yellow on prearcular and costal regions, with an abundant reticulate or muscoid pale brown pattern, appearing as transversely parallel zigzag lines in most of the cells, more approximated and subconfluent to form broken bands before the level of origin of *Rs* and along the cord; veins yellow. Venation: A supernumerary crossvein in cell R_3.

Male.—Length about 6—8 mm.; wing 8—10 mm.

Widely distributed throughout the Greater Antilles, in the mountains. Elsewhere widespread in northern South America, in Central America and Mexico.

Puerto Rico: El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

The peculiar banding of the femora and the reticulate wings with a supernumerary crossvein in cell R_3, serve to define the present species. The fly bears a curious superficial resemblance to some species of the Hexatomine genus *Epiphragma*. The relationships existing between *diva* and some other allied Neotropical members of the subgenus have been discussed in the Alexander 1928 paper, above cited.

Subgenus **Dicranomyia** Steph.

Of this abundant and widespread group, only three species have been taken in Puerto Rico. Elsewhere in the Antilles a few additional species are found, but the subgenus is by no means as extensive and characteristic as is *Geranomyia.*

A KEY TO THE PUERTO RICAN SPECIES

1. Wings with cell M_2 open by the atrophy of *m*; *Rs* very short, less than *m-cu*; *Sc* short, Sc_1 ending before the origin of *Rs* a distance about equal to the entire length of the latter .... *brevivena torrida* subsp. n.
   Wings with cell *1st* M_2 closed; *Rs* distinctly longer than *m-cu*; *Sc* longer, Sc_1 ending opposite or only a little before the origin of *Rs*. 2
2. General coloration of thorax brown, with a sparse pollinosity; praescutum with three darker stripes .... *distans* O. S.
   General coloration of thorax yellow, the praescutum without distinct stripes .... *divisa* Alex.

Limonia (Dicranomyia) brevivena torrida subsp. n.

Close to typical *brevivena* O. S. in venation and hypopygial characters, differing chiefly in the details of body-coloration.

Antennae with the scape light yellow. Head with the rostrum, from and anterior vertex yellow, the posterior vertex brownish gray.

Mesonotum yellow to brownish yellow, the praescutum with three clearly defined dark brown stripes, the median one not reaching the suture behind, the lateral stripes crossing the suture and extending to the abdomen, gradually converging behind to leave the central portions of the scutum, scutellum and postnotal mediotergite narrowly pale. Pleura pale yellow, the ventral sternopleurite restrictedly darkened.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard). Allotopotype, alcoholic ♀. Paratopotypes, a few alcoholic ♂ ♀.

The thoracic pattern is quite different from that of more northern specimens that seem to be typical of *brevivena,* s.s.

Limonia (Dicranomyia) distans (O. S.) (Fig. 7)

1859. *Dicranomyia distans* O. S.; Proc. Acad. Nat. Sci. Philadelphia, 1859: 211.

1869. *Dicranomyia distans* O. S.; Mon. Dipt. N. Amer., 4: 67–68.

General coloration brown, with a sparse golden-yellow pollen. Mesonotal praescutum with three darker stripes. Flagellar segments nearly globular. Halteres short. Wings with a faint brown tinge, the stigma scarcely indicated; veins brown. Venation: Sc_1 ending about opposite the origin of *Rs*, Sc_2 some

distance from its tip so that Sc_1 alone is nearly equal in length to *m-cu*; cell *1st* M_2 closed.

Male hypopygium (Fig. 7) readily distinguished from all similar forms by the presence of 3, or more rarely 4, straight spines on the rostral prolongation of the ventral dististyle.

Male.—Length about 4.5 mm; wing 4.5—5.5 mm.

Female.—Length about 5.5—6 mm.; wing 5.5—6 mm.

A common species in the southern United States, occurring much farther south on the mainland, reaching its southern limit in Paraguay; Puerto Rico.

Puerto Rico: Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard). Río Piedras, February 1932 (M. D. Leonard).

Limonia (Dicranomyia) divisa Alex. (Fig. 8)

1859. *Dicranomyia diversa* O. S.; Proc. Acad. Nat. Sci. Philadelphia, 1859: 212, name preoccupied.

1929. *Limonia* (*Dicranomyia*) *divisa* Alex.; Philippine Journ. Sci., 40: 247.

General coloration of body yellow. Head darkened. Antennae pale brown, the basal segments paler. Halteres with the knobs darkened. Wings with a faint brownish tinge, the oval stigma slightly darker. Venation: Sc_1 ending shortly before the origin of *Rs*, Sc_2 some distance from its tip, Sc_1 alone subequal to or longer than *m-cu*; cell *1st* M_2 closed. Male hypopygium (Fig. 8) distinctive in structure, the rostral prolongation of the ventral dististyle being deeply and conspicuously bifid at apex, while the basistyle has the ventro-mesal lobe very large and complicated by lobules and groups of rows of setae of various shapes and sizes.

Male.—Length about 3.5—4 mm.; wing 4—4.5 mm.

Eastern North America, recurring in the mountains of Hispaniola and Puerto Rico.

Puerto Rico: El Yunque, 1800 feet, February 11, 1930 (M. D. Leonard). The same, altitude 2000-3500 feet, March 29, 1930 (M. D. Leonard).

Subgenus **Rhipidia** Meig.

Besides the common and widespread *domestica*, discussed below, two other species of *Rhipidia* occur in the Greater Antilles and may be found in Puerto Rico. *L.* (*R.*) *schwarzi* (Alex.) is widely distributed in the southeastern United States and West Indian islands. It is readily told from *domestica* by the numerous brown dots in all cells of wing and by the broad pale yellow border to the mesonotal praescutum. Both of these flies belong to the so-called *domestica*

group, having the antennae of the male merely subpectinate. A second regional species, *L.* (*R.*) *subcostalis* (Alex.) is known from Jamaica and Central America. This fly belongs to a very different group of *Rhipidia* and may readily be distinguished by the conspicuous pale yellow posterior tarsi. For a more detailed account, consult a paper by the writer (The Crane-flies of Jamaica. Dept. Sci. and Agr. Jamaica, Ent. Bull. 4: 19–29; 1928).

Limonia (Rhipidia) domestica (O. S.)

1859. *Rhipidia domestica* O. S.; Proc. Acad. Nat. Sci. Philadelphia, 1859; 208.

1869. *Rhipidia domestica* O. S.; Mon. Dipt. N. Amer., 4, pl. 3, fig. 5 (male hypopygium).

1912. *Rhipidia domestica* Alex.; Bull. Brooklyn Ent. Soc., 8: 15–16, pl. 1, fig. g (wing).

1919. *Rhipidia domestica* Alex.; Crane-flies of New York, part 1, pl. 32, fig. 40 (wing).

Antennae subpectinate, appearing moniliform; segments black, with the penultimate and antepenultimate (12th and 13th) segments abruptly pale yellow. Head dark gray.

Mesonotal praescutum with the stripes dark brown, the interspaces with a golden-yellow pollen. Legs obscure yellow, the tips of the femora and tibiae weakly darkened. Wings subhyaline, the centers of most of the cells streaked longitudinally with pale gray; a series of about five darker spots along the costal border of wing; stigmal area ring-like, with a pale center. Venation: Sc_1 ending just before midlength of *Rs*; *m-cu* some distance before the fork of *M*, in cases the distance exceeding *m-cu* itself.

Male.—Length about 4.5—6 mm.; wing 5.5.—7 mm.
Female.—Length about 6—6.5 mm.; wing 6—7 mm.

Widely distributed throughout the southern United States, from the Carolinian zone southward throughout the Antilles and on the continent to Argentina.

Puerto Rico: Manatí, June 27–29, 1915 (A.M.N.H.). Santurce, April 4, 1930 (M. D. Leonard). Río Piedras, March 12, 1930 (M. D. Leonard). Coamo Springs Hotel, at light, April 4, 1930 (M. D. Leonard). Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

The fly is readily told by the coloration of the antennae, the two subterminal segments being pale yellow, contrasting abruptly with the blackened remainder of the organ. *L.* (*R.*) *schwarzi* has a somewhat similar antennal pattern, but is readily distinguished by the coloration of the wings and thorax, as described above.

Subgenus **Geranomyia** Hal.

Rather numerous species of *Geranomyia* occur in Puerto Rico. In addition to these forms, which are keyed and discussed below, a few other species are known from the other Antillean islands and may be found in Puerto Rico. Elsewere in the Neotropics, the subgenus is represented by a host of species.

The larvae of the known species are chiefly members of the hygropetric associations found on the wet faces of cliffs, at margins of streams and in similar places. The adults suck the nectar of various flowers by means of their long conspicuous beaks. The only other crane-flies in the fauna with elongate rostra are *Elephantomyia* and *Toxorhina,* in which the entire frontal region of the head is drawn out into a filiform structure, with the reduced mouthparts at the extreme tip. In *Geranomyia,* however, several structures take part in the formation of the rostrum, the longest and most conspicuous elements being the paired labial palpi.

A KEY TO THE PUERTO RICAN SPECIES

1. Wings unmarked, except for the stigmal spot when this is present 2
   Wings with a restricted dark pattern, in addition to the stigmal area 6
2. Sc_1 ending opposite the origin of *Rs* 3
   Sc_1 ending distinctly beyond the origin of *Rs*, about opposite one-fifth to one-third the length of the vein 5
3. Fore tibiae with the tips blackened and slightly enlarged 4
   Fore tibiae not blackened or enlarged at tips .... *rufescens* (Lw.)
4. Male hypopygium with the spines of the rostral prolongation of the ventral dististyle exceeding twice the length of the prolongation alone; gonapophyses with the mesal-apical lobe distinctly bidentate at apex .... *tibialis* (Lw.)
   Male hypopygium with the spines of the rostral prolongation of the ventral dististyle shorter, a little longer than the prolongation itself; gonapophyses with merely a lateral flange on the mesal-apical lobe .... *mycrsiana* Alex.
5. General coloration gray, the praescutum with a median blackish stripe; rostrum short, approximately one-third the length of the body .... *cincreinota* (Alex.)
   General coloration in life pale green, paling to yellow or greenish yellow in dead specimens; rostrum elongate, exceeding one-half the length of the body .... *virescens* (Lw.)
6. Wings with a very restricted dark pattern; apex of wings beyond level of stigma and tips of the Anal veins without dark markings; fore tibiae not darkened at tips .... *subrecisa* sp. n.
   Wings with the dark pattern more extensive, including clouds in the apical cells and at ends of both Anal veins; fore tibiae conspicuously blackened and enlarged at tips .... *antillarum* Alex.

Limonia (Geranomyia) antillarum Alex.

1929. *Limonia (Geranomyia) antillarum* Alex.; Journ. N. Y. Ent. Soc., 37: 395–396.

Mesonotal praescutum with four brownish gray to gray stripes, the lateral pair usually clearer gray than the intermediates, the interspaces brown to black. Pleura buffy-gray, variegated with dark brown. Legs with the femora yellow, with a broad brown subterminal ring; tips of tibiae darkened, especially the fore tibiae which are slightly swollen and blackened. Wings with a restricted dark brown pattern; area over origin of *Rs* narrow, oblique, its proximal end lying over end of vein *Sc*; stigmal area shallow, its posterior edge not or but slightly passing caudad of vein R_{2+3}. Abdomen brown, the caudal margins of the segments narrowly pale.

Male.—Length, excluding rostrum, about 7—7.5 mm.; wing 7.5—8 mm.; rostrum about 3 mm.

Female.—Length, excluding rostrum, about 8—9 mm.; wing 7.3—8 mm.; rostrum about 3.2—4 mm.

Known from all four major islands of the Greater Antilles.

Puerto Rico: Coamo Springs Hotel, at light, April 4, 1930 (M. D. Leonard); the same, April 10, 1930 (W. T. M. Forbes).

This species is allied to and has been confused with the more northern *L.* (*G.*) *rostrata* (Say). From this latter species, it differs especially in its larger size, subterminal darkened rings on femora, narrower wings, with a slightly different pattern, and in the details of the male hypopygium.

Limonia (Geranomyia) cinereinota (Alex.)

1913. *Geranomyia cinereinota* Alex.; Ent. News, 24: 407–408, pl. 14, fig. 4 (wing).

1916. *Geranomyia domingensis* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1916: 490–491.

Rostrum short, as shown by the measurement. Head black, enclosing a silvery triangle. Mesonotal praescutum gray, with a broad blackish median line. Legs with the femora obscure yellow; tibiae and tarsi passing to brown. Wings nearly hyaline, the stigma small and relatively indistinct. Venation: Sc_1 ending about opposite one-fourth the length of *Rs*. Male hypopygium with the lateral lobes of the ninth tergite conspicuously setiferous. Rostral prolongation of the ventral dististyle elongate, the two rostral spines placed at and before midlength, separated from one another by a distance about equal to the basal tubercle of one; spines unequal, the outer about one-third to one-half longer than the inner spine.

Male.—Length, excluding rostrum, about 5—5.5 mm.; wing 6.5—7 mm.; rostrum about 1.8 mm.

Female.—Length, excluding rostrum, about 5.5—6 mm.; wing 5.5—7 mm.; rostrum about 1.6 mm.

Northern South America, northward in the Antilles to Puerto Rico and Hispaniola.

Puerto Rico: Mameyes, November 19, 1925 (A.M.N.H. No. F 5114 A). Río Piedras, March 12, 1930 (M. D. Leonard). Luquillo National Forest, May 10–13, 1927 (W. A. Hoffman). El Yunque, Luquillo, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Limonia (Geranomyia) myersiana Alex.

1929. *Limonia* (*Geranomyia*) *myersiana* Alex.; Journ. N. Y. Ent. Soc., 37: 397–398.

General coloration pale brown. Mesonotal praescutum with three narrow pale brown stripes. Tips of fore tibiae conspicuously blackened. Wings faintly tinged, unmarked except for the oval, pale brown stigma. Venation: *Sc* short, Sc_1 ending opposite or shortly before origin of *Rs*. Male hypopygium with the mesal-apical lobe of the gonapophyses slender, gently curved, the outer edge bearing a small flange. Dorsal dististyle considerably longer than in *tibialis*.

Male.—Length, excluding rostrum, about 4—4.5 mm.; wing 5.3—6 mm.; rostrum about 2.3—2.7 mm.

Known only from Cuba and Puerto Rico.

Puerto Rico: El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Allied to *L.* (*G.*) *tibialis* (Lw.), yet well-distinguished by the structure of the male hypopygium.

Limonia (Geranomyia) rufescens (Lw.)

1851. *Aporosa rufescens* Lw.; Linn. Ent., 5: 396–397, figs. 9–12.

General coloration of body reddish yellow, more intense on the thoracic dorsum. Mesonotal praescutum with three brownish black longitudinal stripes, the median one broader. Knobs of halteres infuscated. Tips of femora and tibiae slightly darkened, but the fore tibiae not enlarged or blackened at tips. Wings with a grayish brown suffusion; stigma large, brown.

Female.—Length, excluding rostrum, about 5 mm.

Known only from Puerto Rico: Loew's original type, collected by Moritz.

There is great uncertainty as to the identity of this species. Lowe's description and figures indicate that the fore tibiae are not blackened at tips, otherwise the fly is almost exactly like what we have identified as *L.* (*G.*) *tibialis* (Lw.). The only fly that answers the description given by Loew that has been discovered in the Antilles is *tibialis* and it is possible that the two species are identical. However, since Loew distinctly figures *rufescens* as having the fore legs present in his type, it seems advisable for the present to retain *rufescens* as being distinct from *tibialis*.

Limonia (Geranomyia) subrecisa sp. n.

Allied to *recisa;* general coloration of mesonotum light brown, with a pale yellow central stripe that is further split on praescutum by a median brown vitta; femora with a narrow pale brown subterminal ring; wings with a very restricted dark pattern; Sc_1 ending opposite origin of *Rs;* a supernumerary crossvein in cell *Sc;* male hypopygium with the rostral spines arising from small to scarcely evident tubercles; gonapophyses with the mesal apical lobes wider than in *recisa.*

Male.—Length, excluding rostrum, about 5 mm.; wing 5.3 mm.; rostrum about 1.8 mm.

Female.—Length, excluding rostrum, about 6 mm.; wing 5.5 mm.; rostrum about 2 mm.

Described from alcoholic specimens.

Rostrum relatively short, dark brown, the extreme tips of the labial palpi pale. Antennae brown throughout; flagellar segments oval. Head dark gray, with a narrow silvery line.

Pronotum brown. Mesonotum light brown, traversed by a pale yellow central vitta extending the entire length of the notum, wider on the praescutum and here enclosing a darker brown median vitta; on posterior sclerites the pale central vitta is narrowly margined with darker. Pleura chiefly testaceous brown. Halteres pale, the knobs infuscated. Legs with the coxae and trochanters yellow; femora yellow, the tips somewhat clearer yellow, preceded by a narrow pale brown ring; tibiae and tarsi brownish yellow. Wings grayish subhyaline, with a very restricted brown pattern, the most evident areas being three in number, including the stigma and small clouds at the supernumerary crossvein in cell *Sc* and over the origin of *Rs* and tip of *Sc*; cord very vaguely seamed with brown; veins brown. Venation: Sc_1 ending opposite origin of *Rs*, Sc_2 at its tip; a supernumerary crossvein just beyond midlength of cell *Sc*; *m-cu* close to fork of *M*; cell *2nd A* narrow.

Abdomen brownish yellow, variegated by darker brown, the latter chiefly on the lateral and caudal portions. Male hypopygium with the caudal margin of tergite strongly emarginate, the lobes with strong setae. Basistyle relatively small, the ventro-mesal lobe large. Dorsal dististyle a gently curved rod, its apex suddenly narrowed to a point. Ventral dististyle large and fleshy; rostral prolongation slender, the two slender rostral spines placed close together near base of prolongation which they exceed in length; spines arising from very small, scarcely evident tubercles. Gonapophyses with the mesal apical lobe wider than in *recisa.*

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard). Allotopotype, alcoholic ♀.

Limonia (Geranomyia) subrecisa is most nearly allied to *L. (G.) recisa* Alex. (Mexico–El Salvador) in the short *Sc,* in conjunction with the wing-pattern and general structure of the male hypopygium.

It differs most decisively in the narrow cell *2nd A* of the wings and in genitalic structures, as the reduced basal tubercles of the rostral spines of the ventral dististyle and in the broader apical lobes of the gonapophyses.

Limonia (Geranomyia) tibialis (Lw.)

1851. *Aporosa tibialis* Lw.; Linn. Ent., 5: 397–398.

Rostrum long, black. General coloration of mesonotum light brownish yellow, the praescutum with three narrow but distinct dark brown stripes, the median stripe longest, narrowed behind. Legs chiefly obscure yellow, the tips of the femora weakly infumed; tips of tibiae narrowly darkened, of the fore tibiae slightly swollen and intensely blackened. Wings with a sandy suffusion, the stigma a little darker. Venation: Sc_1 ending opposite origin of *Rs*, Sc_2 at its tip. Male hypopygium with the rostral spines of the ventral dististyle long and straight, divergent, each arising from a small basal tubercle. Gonapophyses bifid at apices.

Male.—Length, excluding rostrum, about 4.5—5 mm.; wing 5—5.5 mm.; rostrum about 2.8—3 mm.

Female.—Length, excluding rostrum, about 5.5—6 mm.; wing 5.5—6 mm.; rostrum about 3—3.5 mm.

Originally described from Brazil, now known to have a vast range in the Neotropics.

Puerto Rico: Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

Limonia (Geranomyia) virescens (Lw.)

1851. *Aporosa virescens* Lw.; Linn. Ent., 5: 398.

General coloration of entire insect pale green, fading in death to yellow, but usually with persistent green tints on some parts of body. Antennae black; flagellar segments subglobular. Mesonotum without markings. Wings nearly hyaline, the stigma pale brown. Venation: Sc_1 ending some distance beyond origin of *Rs*.

Male.—Length, excluding rostrum, about 4 mm.; wing about 5 mm.; rostrum about 2.8 mm.

Described from the island of St. Thomas, Virgin Island, collected by Moritz. The reference of the Puerto Rican specimens to *virescens* is rendered somewhat doubtful because of inability to study the detail of structure of the male hypopygium of the type. A small number of allied species of small green *Geranomyia* are now known from Middle America.

Puerto Rico: Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard).

Subtribe Heliaria

The only included genus in this subtribe is *Helius* St. Farg., rich in species and occurring in all regions of the World. In the Greater Antilles, two species occur, with one in Puerto Rico.

Helius (Helius) albitarsis (O. S.) (Fig. 5)

1887. *Rhamphidia albitarsis* O. S.; Berlin. Ent. Zeitschr., 31:184.

General coloration rather dark brown, the pleura paler, more yellowish. Rostrum about one-third longer than the remainder of head, brownish. Antennnae black throughout; verticils considerably longer than the segments. Legs dark brown, the distal half of tarsi white or whitish. Wing (Fig. 5) with a strong blackish tinge, the elongate stigma even darker brown. Venation: Sc_1 ending before termination of *Rs*, Sc_2 *at* its tip; *r-m* very short or obliterated by the fusion of veins R_{4+5} and M_{1+2}; cell *1st* M_2 large, roughly pentagonal or hexagonal in outline, the longest elements being the two sections of M_{1+2}; *m-cu* at near midlength of the cell. Abdomen, including the hypopygium, black.

Male.—Length about 6—7 mm.; wing 6.5—7.5 mm.

Female.—Length about 6.5—8 mm.; wing 6.5—8.5 mm.

The species is widely distributed in Central and northern South America.

Puerto Rico: The type, a ♂, was taken in Puerto Rico by Moritz. Luquillo National Forest, May 10–13, 1927 (W. A. Hoffman).

Helius albitarsis is readily told by the dark coloration of the body and wings, in conjunction with the white feet. In the present fauna, the only other crane-fly having this general size and appearance is *Trentepohlia* (*Paramongoma*) *niveitarsis* (Alex.), a very different fly. The Jamaican *Helius creper* Alex. is well-distinguished from *albitarsis* by the venation, notably the small cell *1st* M_2 and consequent full development of the *r-m* crossvein.

(No representatives of the genus *Orimarga O. S.*, sole American genus in the subtribe Orimargaria, have yet been taken in Puerto Rico. Both the typical subgenus and *Diotrepha* O. S. are found in Cuba and it seems highly probable that *Orimarga* (*Diotrepha*) *mirabilis* (O.S.) will be found to occur in Puerto Rico. It is readily told by the very remarkable venation (Fig. 9), notably the basal position of *m-cu*. The fly is an elongate insect, grayish, with long white legs, the femora with broadly blackened tips, the tibiae more narrowly so. A new Cuban member of the typical subgenus is described later in the present report.)

Tribe HEXATOMINI

The Hexatomine crane-flies are not strongly represented in the Greater Antilles. In Puerto Rico, three genera occur. Elsewhere

in the islands, a few additional groups are found (*Epiphragma, Atarba, Elephantomyia*). *Epiphragma* includes medium-sized to rather large crane-flies with the wings handsomely banded and variegated with brown and with the femora variously ringed with yellow and dark brown or black (Fig. 14). *Elephantomyia* is readily told by the greatly produced front, the only other local crane-fly with such a type of rostrum being the Eriopterine genus *Toxorhina* which is readily told from all other crane-flies by having a single branch of *Rs* reaching the wing margin (compare *Elephantomyia*, fig. 13 and *Toxorhina*, fig. 19). *Atarba* has many species in the Neotropics and representatives may well be expected to occur in Puerto Rico.

Subtribe Polymeraria

Includes in America only the genus *Polymera* Wied., a large and eminently characteristic genus in the Neotropics, with more than a score of described forms. Two species range northward into the southeastern United States, while two others occur in the Greater Antilles. Of these, only *geniculata* has been taken in Puerto Rico. *Polymera obscura* Macq. has been found in Cuba, thence ranging southward over most of South America.

Polymera (Polymera) geniculata Alex. (Fig. 10)

1915. *Polymera geniculata* Alex.; Insec. Inscit. Menst., 3: 106–107.

Flagellar segments of male binodose; brownish black, the second to sixth segments narrowly and indistinctly paler at incisures. Legs brown, the genua pale, the conspicuous pale femoral tip preceded by a darker brown ring; extreme base of tibia similarly pale; tarsi brown, the posterior tarsi of a slightly paler shade than the remaining tarsi. Wings (Fig. 10) with R_{1+2} about twice R_2 alone, basal section of R_5 slightly arcuated, a little longer than *r-m*; *m-cu* just beyond the fork of *M*; cell M_1 shallow.

Male.—Length about 4 mm.; wing 4.8 mm.; antenna about 7—8 mm.

Known only from Puerto Rico. Type, Carolina, altitude 100 feet, in crab-holes under rocks, September 11, 1914. A second specimen was reared by W. A. Hoffman from a pupa taken February 20, 1927, in an eddy of a rapidly flowing rocky stream at Barranquitas, where it was associated with larvae of a species of *Dixa*; the adult emerged February 21, 1927.

Subtribe Limnophilaria

The vast subtribe Limnophilaria is represented in the Greater Antilles only by several diverse species of *Shannonomyia* Alex.

Genus **Shannonomyia** Alex.

1929. *Shannonomyia* Alex.; Diptera Patagonia and South Chile, 1: 142–143.

The species of *Shannonomyia* are numerously represented in South America. In the Greater Antilles, 6 species have been discovered, there being two each in Cuba, Puerto Rico and Jamaica. No representatives of the genus have yet been taken in Hispaniola but must certainly occur. The Antillean species show some remarkable tendencies of venation, notably the shortening of vein *Sc* and the reduction in size of cell R_3 of the wings. In cases, cell *1st* M_2 is greatly lengthened (as in *leonardi*, fig. 11). In still other species, the cell is open by the atrophy of crossvein *m* (as *myersiana* Alex., *nacrea* Alex., *triangularis* Alex.). The Jamaican *S. myersiana* is very remarkable in the elongate antennae of the male sex and in the presence of macrotrichia in the apical cells of the wing.

A KEY TO THE PUERTO RICAN SPECIES

1. Cell *1st* M_2 of the wings elongate, closed, exceeding the veins beyond it (Fig. 11); wings with a restricted brown spotted pattern___*leonardi* sp. n.
   Cell *1st* M_2 open by the atrophy of *m*; wings unmarked, except for the small stigmal area_____________________________________*triangularis* Alex.

Shannonomyia leonardi sp. n. (Fig. 11)

General coloration pale yellow; wings yellow with a restricted dark brown spotted pattern that is confined to the veins and crossveins; *Sc* short, R_3 about one-half R_{3+4}, cell R_3 being short; cell *1st* M_2 closed, long and narrow, exceeding any of the veins beyond it.

Male.—Length about 4 mm.; wing 3.8—4 mm.

Female.—Length about 5 mm.; wing 3.5.

Described from alcoholic specimens.

Rostrum yellow; palpi dark brown. Antennae short in both sexes; scape and pedicel yellow; the short, crowded flagellar segments dark brown. Head pale yellow.

Mesonotal praescutum and scutum bright yellow, the remainder of dorsum more whitish yellow; scutellum more or less darkened. Pleura whitish yellow. Halteres pale. Legs with the coxae and trochanters whitish; remainder of legs broken. Wings (Fig. 11) yellow, with a restricted dark brown spotted pattern, as follows: At arculus; origin of *Rs*; Sc_2, the last two elements sometimes confluent; stigma; cord and outer end of cell *1st* M_2; marginal seams on veins R_3, M_{1+2}, M_3, M_4, Cu_1 and *2nd A*; veins yellow, brown in the darkened areas. Venation: Prearcular cells extensive; *Sc* unusually short, Sc_1 ending shortly beyond origin of *Rs*, Sc_2 a short distance from its tip; R_2 subequal to R_{1+2}; *Rs* of moderate length, angulated and weakly spurred at origin; cell R_3 relatively short, R_3 being about three-fourths of R_{3+4}; cell *1st* M_2 long and narrow, exceeding any of the veins beyond it; *m* and basal section of M_3 subequal; *m-cu* beyond fork of *M*; vein *2nd A* curved into *Anal* margin.

Abdomen brownish yellow, the lateral margins narrowly darker; hypopygium pale, only the tips of the outer dististyle blackened.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard). Allotopotype, alcoholic ♀. Paratopotype, alcoholic ♂.

I take great pleasure in naming this distinct crane-fly in honor of the collector, Dr. Mortimer D. Leonard. The species is very different from all other described members of the genus, being readily told by the combination of spotted wings, unusually short *Sc* and elongate cell *1st* M_2. The medial field is about as in the Cuban *S. mesophragma* Alex., but the other details of venation are quite different.

Shannonomyia triangularis (Alex.)

1927. *Pilaria triangularis* Alex.; Journ. N. Y. Ent. Soc., 35: 270–271.

General coloration pale brown. Head brownish black, paler anteriorly. Antennae with scape and pedicel obscure yellow; flagellum dark brown. Femora and tibiae very pale brown. Wings grayish subhyaline, the small stigma pale brown. Venation: *Sc* of moderate length, Sc_1 ending between one-third and one-half the length of *Rs*; cell R_3 small and triangular in outline, somewhat as in species of the Eriopterine subgenus *Gonomyia*; cell *1st* M_2 open by the atrophy of *m*; *m-cu* at or only shortly beyond the fork of *M*. In some specimens, cell R_3 is a little deeper but in all cases originates beyond the level of vein R_2.

Male.—Length about 4.5 mm.; wing 4—4.5 mm.

Female.—Length about 5 mm.; wing 5 mm.

Known only from Puerto Rico and apparently restricted to the mountainous section of the Luquillo National Forest. Type, May 10–13, 1927 (W. A. Hoffman). Also at 1800 feet, February 11 and March 29, 1930 (M. D. Leonard).

Subtribe HEXATOMARIA

The subtribe includes the single genus *Hexatoma* Latr., now considered as having three subgenera, one of which, *Eriocera* Macq., is found in the Greater Antilles. *Eriocera* is one of the largest and most characteristic groups of crane-flies in the World, with approximately 200 described species of large and usually showy flies. These are most characteristic of the tropics of both hemispheres. In the Antilles, eight species have now been discovered, forming a somewhat peculiar group. These species are found in all four of the major islands but no one species occurs in more than a single island.

It is very probable that several additional species will be discovered as a result of future collecting.

The early stages of *Eriocera* are aquatic or nearly so, the large carnivorous larvae going to dryer land to pupate. The adults sometimes occur in large swarms, usually close to large streams or rivers.

A KEY TO THE PUERTO RICAN SPECIES

1. Wings with three darkened bands, the first at the wing-root, the second at origin of *Rs*, extending across the wing and being connected with the basal band in the Anal cells; wing-apex chiefly dark, with the centers of cells R_4, R_5, *2nd* M_2 and M_3 grayish-hyaline; thorax yellowish with a grayish blue pruinosity, especially on the pleura and coxae; abdomen with blackish bands on anterior margins of the segments, the incisures yellowish -- *trifasciata* (Röder)

   Wings with an interrupted brown pattern that is ocelliform at the origin of *Rs*; thorax light orange, unmarked; abdomen without blackish bands on the segments, the terminal two segments uniformly blackened ------ -- *ocellifera* Alex.

Hexatoma (Eriocera) ocellifera (Alex.)

1915. *Eriocera ocellifera* Alex.; Insec. Inscit. Menst., 3:104–105.

Antennae pale. Head dark. Thorax entirely clear light orange. Femora dull yellow, their apices narrowly dark brown; tibiae and tarsi black. Wings light yellow, with cell *C* dark brown; an interrupted narrow dark band along cord; an ocelliform darkening centering at origin of *Rs*; wing-tip narrowly margined with brown. Venation: Cell M_1 lacking; R_{2+3} about one-half longer than R_2. Abdomen orange, the terminal two segments blackened.

Male.—Length about 10.5 mm.; wing 9.8 mm.

Known only from the unique type, taken at Mayagüez, December 4, 1913, by R. H. Van Zwaluwenburg, now in the U. S. National Museum.

Hexatoma (Eriocera) trifasciata (Röder)

1885. *Eriocera trifasciata* Röder; Stett. Ent. Zeitig., 46 338.

The detailed diagnosis given in the above key includes about all that is known of this fly.

Like the last, is is known from the unique type only, this having been taken in Puerto Rico by Gundlach, who reports the species as being rare.

The venation of the closely allied *H.* (*E.*) *cubensis* (Alex.) is shown (Fig. 12).

Tribe ERIOPTERINI

Several genera and subgenera of this great tribe are found in the Greater Antilles, the most abundant and characteristic groups

being *Gonomyia, Teucholabis* and *Erioptera.* The small species of the subgenus *Lipophleps* (*Gonomyia*) are especially well-represented in Puerto Rico.

Subtribe Gonomyaria

This includes only *Gonomyia* and *Teucholabis* in the Antilles. Of these, only *Gonomyia,* with a single subgenus *Lipophleps* Bergr., is found in Puerto Rico. *Lipophleps* is a very extensive group, with approximately 100 described species, distributed in all regions of the World but especially characteristic of the American tropics. Members of this group are often swept from rank vegetation near water. The adults, especially the females, are commonly attracted to lights in the evening and may be found in houses the following day.

A KEY TO THE PUERTO RICAN SPECIES

(Based especially on male genitalic characters)

1. Wings with cell M_2 open by the atrophy of the basal section of M_3; costal border conspicuously whitened; tibiae china-white, tipped with dark brown (*cinerea* group) ---------- *helophila* Alex.
   Wings with cell *1st* M_2 closed; costal border yellow or brown, not whitened; legs without white coloration ---------- 2
2. Wings with the stigmal spot dark brown, contrasting strongly with remainder of wing; male hypopygium with the apex of basistyle produced into a slender black spine. (*pleuralis* group) ---------- *pleuralis* (Will.)
   Wings with the stigma lacking or scarcely evident against the ground-color; male hypopygium with apex of basistyle without any spinous developments. (*manca* group) ---------- 3
3. Male hypopygium with a single, entirely fleshy dististyle that is terminal in position; elements of phallosome two in number very long and slender, jutting caudad beyond level of end of dististyle (Fig. 21) ---------- *bifiligera* sp. n.
   Male hypopygium with the dististyle subterminal in position, the outer lobe of basistyle being more or less produced caudad into a pale fleshy lobe; elements of phallosome not conspicuously produced (Figs. 22–24) ---------- 4
4. Male hypopygium with the dististyle not blackened, fleshy, on outer margin near base bearing a small pale triangular point; outer lobe of basistyle subequal in length and general appearance to the dististyle (Fig. 24) ---------- *subterminalis* Alex.
   Male hypopygium with the outer dististyle a strongly curved hook or spine, entirely blackened and sclerotized, very dissimilar in appearance to the outer lobe of the basistyle (Figs. 22–23) ---------- 5
5. Outer lobe of basistyle greatly produced, subequal in length to the very long, slender outer dististyle (Fig. 23) ---------- *producta* Alex.
   Outer lobe of basistyle relatively short and stout, much shorter than the powerfully constructed hook-like outer dististyle (Fig. 22) ---------- *bicornuta* Alex.

Gonomyia (Lipophleps) bicornuta Alex. (Fig. 22)

1927. *Gonomyia (Lipophleps) bicornuta* Alex.; Journ. N. Y. Ent. Soc., 35: 276–277.

Belongs to the *manca* group. General coloration brown and sulphur-yellow. Rostrum and antennae black. Thoracic pleura with a broad whitish longitudinal stripe. Knobs of halteres yellow. Wings brownish gray, without stigma. Male hypopygium (Fig. 22) with the basistyle produced into a short fleshy lobe that is shorter than the outer dististyle. Outer dististyle a powerful blackened hook, symmetrical on the two sides; inner dististyle very small, with a few setae and a single powerful fasciculate bristle. Phallosome symmetrical, the aedeagus terminating in two pale rounded blades. Two entirely dusky blades, entirely glabrous, subtend the aedeagus; in addition to these there are two shorter lobes of nearly equal width, bearing several weak setae on their apical half.

Endemic in Puerto Rico. Known only from the Luquillo National Forest. Type, May 10–13, 1927 (W. A. Hoffman). An additional ♂, El Yunque, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Gonomyia (Lipophleps) bifiligera sp. n. (Figs. 15, 21)

Belongs to the *manca* group; general coloration of mesonotum dark brown, the scutellum yellow; antennal pedicel large, blackened; thoracic pleura yellow, striped with dark brown; legs brownish black; wings grayish, stigma lacking; male hypopygium with the basistyles very long and slender; a single, entirely fleshy dististyle; elements of phallosome two in number, very long and slender, extending caudad beyond the level of the distal ends of styli.

Male.—Length about 2.5 mm.; wing 2.8—3 mm.

Described from alcoholic specimens.

Rostrum obscure yellow; palpi dark brown. Antennae brownish black, the pedicel enlarged and more intensely blackened. Head obscure yellow in front, more grayish brown on posterior vertex and occiput, the posterior orbits broadly yellow.

Mesonotum chiefly dark brown, the scutellum and posterolateral portions of scutal lobes yellow. Pleura yellow, with two conspicuous, dark brown, longitudinal stripes, the more dorsal one widest on anepisternum, narrowed behind to a sutural marking along ventral edge of pteropleurite; ventral stripe more extensive, including the sternopleurite and meral region. Halteres dusky, the knobs pale yellow. Legs with the coxae yellow, the fore coxae darkened; trochanters chiefly dusky; remainder of legs brownish black. Wings (Fig. 15) with a strong grayish tinge; stigma lacking; veins pale brown. Venation: Sc_1 ending some distance before origin of *Rs*, the distance on costa being nearly equal to *Rs* alone; branches of *Rs* strongly divergent.

Abdominal tergites light brown, the sternites and hypopygium more yellowish. Male hypopygium (Fig. 21) with the basistyles very long and slender, the single dististyle entirely fleshy, terminating in two stout fasciculate setae. Phallosome

consisting of two very elongate, slender structures that extend caudad beyond the level of the tips of the styli; one rod at apex bears abundant short setae, the second structure more slender, glabrous, very gradually narrowed to an acute point.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard). Paratopotypes, 3 alcoholic ♂♂.

Gonomyia (*Lipophleps*) *bifiligera* is allied to species such as *G.* (*L.*) *cubana* Alex., yet is very distinct in the structure of the male hypopygium, notably the two filiform rods of the phallosome.

Gonomyia (Lipophleps) helophila Alex. (Fig. 20)

1916. *Gonomyia* (*Leiponeura*) *helophila* Alex.; Ent. News, 27: 343–346, fig. 1 (wing), 3 (male hypopygium).

1916. *Gonomyia* (*Leiponeura*) *helophila* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1916: 514, pl. 29, fig. 60 (male hypopygium).

Belongs to the *cincrea* group. Antennal scape brownish black beneath, remainder of organ yellowish brown. Head yellow, with a brownish mark on vertex. Mesonotal praescutum light gray, with four more brownish stripes. Pleura dark brown, with two whitish longitudinal stripes. Legs with the fore femora brownish black; middle femora yellow, tipped with dark brown; hind femora brownish yellow, the tips slightly more darkened; tibiae white, the extreme base and slightly broader apex dark brown. Wings with costal margin china-white; remainder of wing subhyaline; stigma oval, brown, preceded and followed by more whitish spots. Venation: Sc_1 ending some distance before origin of *Rs*. Abdominal tergites brown, their caudal margins light yellow. Male hypopygium (Fig. 20) with a slender outer spinous dististyle. Ventral dististyle with a blackened finger-like lobe on margin near base. Dorsal dististyle a small oval unarmed lobe.

Male.—Length about 4.5—5.2 mm.; wing 5—5.5 mm.

Female.—Length about 4.8—5.5 mm.; wing 5.2—5.8 mm.

Ranges from Texas, south on continent to Peru; in the Antilles, Puerto Rico and Dominica.

Puerto Rico: Santurce, March 1932 (M. D. Leonard). Coamo Springs, July 17–19, 1914 (A.M.N.H.). Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

The only local representative of a very extensive group of chiefly Neotropical Gonomyiæ. It is readily told by the open cell M_2 of the wings, together with the white costal border, and the china-white tibiae.

Gonomyia (Lipophleps) pleuralis (Will.).

1896. *Atarba pleuralis* Will.; Trans. Ent. Soc. London 1896: 289, pl. 10, fig. 61 (wing).
1912. *Gonomyia* (*Leiponeura*) *pleuralis* Alex.; Ent. News, 23: 419–420, figs. 3, 4 (male hypopygium).
1916. *Gonomyia* (*Leiponeura*) *pleuralis* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1916: 516, pl. 26, fig. 20 (wing).

Mesonotum light brownish yellow, margined laterally with whitish, the latter color separated from the dorsum by a narrow darker line. Pleura almost white, striped longitudinally with dark brown. Legs with the trochanters and femora light yellow, the latter with a subterminal brown ring. Wings with a grayish tinge, the costal border narrowly more yellowish; a conspicuous dark brown stigmal area; region of cord variegated by small more hyaline areas. Abdomen yellow, the segments bordered by dark brown.

Male.—Length about 3—3.5 mm.; wing 3—3.3 mm.

A wide-ranging species. Georgia and Florida; Bermudas; southward through the Antilles to British Guiana and Brazil.

Puerto Rico: Aguadilla, January 1899 (A. Busck); U.S.N.M. Coamo Springs Hotel, at light, April 4, 1930 (M. D. Leonard). Santurce, March 26, 1930 (W. A. Hoffman); April 19, 1930 (M. D. Leonard).

Again the only local representative of a very large and widespread group of tropical American Gonomyiæ. It is readily told from the other local *Lipophleps* by the dark brown stigmal area.

Gonomyia (Lipophleps) producta Alex. (Fig. 23)

1919. *Gonomyia* (*Leiponeura*) *producta* Alex.; Journ. N. Y. Ent. Soc., 27: 139–140.

Belongs to the *manca* group. General appearance much as in *bicornuta* Alex., as described. Male hypopygium (Fig. 23) distinctive, notably the long slender apical lobe of the basistyle and the very long and slender, symmetrical outer dististyle. These latter are of a length and slenderness found otherwise only in *G.* (*L.*) *prolixistylus* Alex.

Male.—Length about 2.5—3 mm.; wing 2.5—3.2 mm.

Known only from Antigua, Lesser Antilles, and Puerto Rico.

Puerto Rico: Puerto Real, Vieques Is., at light, September 25–27, 1931 (M. D. Leonard).

Gonomyia (Lipophleps) subterminalis Alex. (Fig. 24)

1927. *Gonomyia* (*Lipophleps*) *subterminalis* Alex.; Journ. N. Y. Ent. Soc., 35: 275–276.

Belongs to the *manca* group. Antennae black throughout. Mesonotum brown, the postnotum variegated with yellow. Pleura striped with pale brown and

testaceous. Wings with an unusually strong dusky tinge. Abdomen dark brown, the hypopygium obscure yellow. Male hypopygium (Fig. 24) with a single, subterminal dististyle that bears a small pale basal triangular point on outer margin near base; outer portion of dististyle with a very powerful subterminal fasciculate seta. The outer lobe of basistyle and the dististyle are generally equal in form and size.

Male.—Length about 3—3.5 mm.; wing 3.6—3.8 mm.

Known only from the mountainous sections of the Luquillo National Forest, Puerto Rico; a very close ally in the Cuban mountains. Type, a male, Luquillo, May 10–13, 1927 (W. A. Hoffman), taken along the steep rocky sides and on the vegetation along a mountain stream. Other material, El Yunque, 1800 feet, February 11, 1930; 2000–3500 feet, March 29, 1930 (M. D. Leonard). Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard).

The peculiar structure of the male hypopygium is very distinctive.

Although only representatives of the subgenus *Lipophleps* have yet been taken in Puerto Rico, three additional subgeneric groups, *Progonomyia* Alex., *Gonomyia* Meig. and *Ptilostena* Berg., have been taken in Cuba and are thus regional.

(The genus *Teucholabis* O. S. is one of the largest and most characteristic groups of Eriopterine Tipulidae, being especially rich in species in tropical America. Several species have been found in Cuba and Jamaica but none, as yet, has been taken in Puerto Rico. The venation of the Cuban *Teucholabis nigrosignata* Alex. is shown, Fig. 16.)

Subtribe Trentepohliaria

Trentepohlia (Paramongoma) niveitarsis (Alex.) (Fig. 17)

1913. *Mongoma niveitarsis* Alex.; Proc. U. S. Nat. Mus., 44: 501, pl. 65, fig. 13 (wing).

1928. *Trentepohlia* (*Paramongoma*) near *niveitarsis* Alex.; Dept. Sci. and Agr. Jamaica, Ent. Bull. 4: 25.

General coloration dark brown, including the head and appendages. Halteres elongate, brown. Legs dark brown, the terminal three tarsal segments white; in cases, the amount of white is more extensive, including all the tarsal segments, as well as the extreme tips of the tibiae. Wings (Fig. 17) subhyaline, the costal margin and stigma somewhat darker brown; veins dark brown.

Male.—Length about 6 mm.; wing about 5 mm.

Female.—Length about 6.5—7 mm.; wing 5.5—6.3 mm.

Known only from the mountains of Puerto Rico and Jamaica. El Yunque, Luquillo National Forest, altitude 2850 feet, February 25–27, 1900 (C. W. Richmond); types. One ♀, Luquillo Forest,

May 10–13, 1927 (W. A. Hoffman). El Yunque, altitude 1800 feet, February 11, 1930 (M. D. Leonard). Also what appears surely to represent this same species, Cinchona, Blue Mts., Jamaica, July 25, 1926 (G. C. Crampton); 1 broken ♂.

This very characteristic fly is the most northerly representative of the great genus *Trentepohlia* in the New World. It bears a superficial resemblance to *Helius* (*Helius*) *albitarsis* (O. S.), which is in reality a very different fly.

Subtribe Eriopteraria

The only representatives of the extensive genus *Erioptera* Meig. in Puerto Rico are members of the subgenus *Mesocyphona* O. S., which reaches its greatest development of species in the American Tropics and Subtropics. Two species of *Mesocyphona* have been taken in Puerto Rico, one of which is widespread throughout eastern North America, the other being endemic. In the high mountains of Jamaica occurs a second subgenus of *Erioptera*, *Empeda* O. S., with a single very distinct species.

A KEY TO THE PUERTO RICAN SPECIES

1. Wings dark brown, with abundant white spots and dots in all the cells................................ *caloptera* Say
   Wings subhyaline, unspotted................................*portoricensis* sp. n.

Erioptera (Mesocyphona) caloptera Say

1823. *Erioptera caliptera* Say; Journ. Acad. Nat. Sci. Philadelphia, **3:17.**

1869. *Erioptera caloptera* O. S.; Mon. Dipt. N. Amer., 4:161–162, pl. 4, fig. 15 (male hypopygium).

1919. *Erioptera caloptera* Alex.; Crane-flies of New York, part 1: 908, pl. 35, fig. 77 (wing).

General coloration brownish yellow, the praescutum with two clearly defined dark brown stripes. Thoracic pleura striped longitudinally with dark brown and pale. Femora yellow, each with two brown annuli, one medial, the other subterminal. Wings brownish, more saturated near costal border, the entire disk variegated by white spots and dots, including somewhat larger areas beyond arculus, at origin of *Rs*, at Sc_2, along cord, and at tips of veins R_{1+2} and R_3.

Male.—Length about 3.5 mm.; wing about 3.5 mm.

Female.—Length about 4 mm.; wing about 3.5 mm.

The species *caloptera* (originally spelled *caliptera* by Say) is widely-distributed throughout the eastern United States. The Puerto Rican material here referred to *caloptera* has the white wing spots

somewhat more reduced in area than do specimens of the typical form from the northern United States.

Puerto Rico: El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930; March 29, 1930 (M. D. Leonard).

Erioptera (Mesocyphona) portoricensis sp. n. (Fig. 18)

Mesonotal praescutum dark brown, with three reddish brown stripes; pleura dark brown, striped longitudinally with whitish; wings immaculate, grayish, the costal border more yellowish; male hypopygium with the phallosome large, produced laterally into a conspicuous straight spine on either side.

Male.—Length about 2.8—3 mm.; wing 2.8—3 mm.

Described from alcoholic specimens.

Rostrum whitish; palpi black. Antennae black; pedicel enlarged, globular; flagellum short, the basal segments crowded. Head whitish, with a conspicuous dark brown area on vertex.

Pronotum dark brown, paler laterally. Mesonotal praescutum dark brown the three usual stripes pale reddish brown; scutum dark brown, the centers of the lobes reddish brown; scutellum whitish; postnotum dark brown. Pleura dark brown with a conspicuous white longitudinal stripe in addition to the broad similarly-colored dorso-pleural region; ventral longitudinal pale line extending from behind the fore coxae to the abdomen, passing beneath the halteres, broadest on the pteropleurite. Halteres pale yellow. Legs with the fore and middle coxae dark brown, the posterior coxae somewhat paler; trochanters pale, especially the posterior ones; fore femora with a single subterminal brown ring; remaining femora with two such darkened rings (the posterior legs are all detached in vials, but the condition seems to be as described). Wings (Fig. 18) grayish, immaculate, more darkened basally, the costal region conspicuously light yellow; veins brownish yellow, clearer yellow in the flavous areas. Venation: Cell M_2 open by atrophy of the basal section of M_3.

Abdomen dark brown, the ninth segment obscure yellow, the styli again conspicuously blackened. Male hypopygium with the dististyles slender; outer style a nearly straight simple rod, the inner style bifid nearly to base, its outer arm longer, the inner arm shorter and very slender. Gonapophyses appearing as simple smooth arms that curve gently toward one another, the obtuse tips dusky. Phallosome large and conspicuous, the body large with a conspicuous lateral spine on either side, these directed laterad and slightly caudad.

Habitat.—Puerto Rico.

Holotype, alcoholic ♂, El Yunque, Luquillo National Forest, altitude 1800 feet, February 11, 1930 (M. D. Leonard).

Paratopotypes, several ♂♂, 1800–3500 feet, February 11—March 29, 1930 (M. D. Leonard); paratypes, a few broken specimens, Las Cruces, altitude 1300 feet, March 28, 1930 (M. D. Leonard).

Erioptera (Mesocyphona) portoricensis is very different from the other described species of the subgenus having unspotted wings.

(The genus *Rhabdomastix* Skuse, subgenus *Sacandaga* Alex., is found in Jamaica and Hispaniola, but to date not in Puerto Rico.

The sole Antillean species is *R.* (*S.*) *parva* (Alex.), a small brown fly with grayish wings. The characters given for the genus in the key will suffice for the separation of this insect. The only regional genus with which it might be confused is *Gonomyia* s.s., which is most readily told by the short to very short *Sc;* in *parva Sc* is long, Sc_1 extending to beyond midlength of *Rs.*)

Subtribe Toxorhinaria

The only genus in this very peculiar subtribe is *Toxorhina* Lw., with a small number of chiefly tropical species in both hemispheres.

Toxorhina (Toxorhina) fragilis Lw. (Fig. 19)

1851. *Toxorhina fragilis* Lw.; Linn. Ent., 5:401–402, pl. 2, fig. 16 (antenna), 17 (entire insect), 18 (venation), 22 (head).

Thorax dark brown, somewhat pruinose; praescutum with a dark gray median stripe but with lateral stripes not clearly evident; extreme lateral margin of praescutum almost whitish. Antennae brownish black. Femora bright brown, darker toward tip; tibiae somewhat brighter, with darker tips. Wings with a faint grayish tinge; stigma lacking; veins of costal region brownish yellow, the others darker brown. Abdomen brown, the incisures darker.

Loew's type, a female, was taken by Moritz in Puerto Rico. Unfortunately no material agreeing entirely with the above diagnosis has ever been taken and it seems probable that the darkening of the tips of the femora and tibiae of *fragilis* is less evident than is implied by Loew's description. I have shown the venation of *Toxorhina* (*Toxorhina*) *centralis* Alex., (Fig. 19), the commonest species in the northern part of South America. The fly that seems closest to *fragilis*, specimens of which I have seen from Cuba and Hispaniola, but not from Puerto Rico, is relatively small.

Male.—Length, excluding rostrum, about 6.5 mm.; wing 6 mm.; rostrum about 5 mm.

V. A List of the Tipulidae Known from the Greater Antilles

TIPULINAE

Nephrotoma, sp. (*ferruginea* Fabr., var.); mss. record. Cuba, Hispaniola.

Tipula (*Tipula*) *jamaicensis* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4:27–28; 1928. Jamaica.

Tipula (*Tipula*) *ludoviciana* Alex.; mss. record. Cuba.

Dolichopeza (*Megistomastix*) *cubensis* (Alex.); Journ. N. Y. Ent. Soc., 36:47–48; 1928 (*Megistomastix*). Cuba.

Dolichopeza (*Megistomastix*) *portoricensis* (Alex.); Psyche, 19:65–66; 1912 (*Megistomastix*). Puerto Rico.

Brachypremna unicolor O. S.; Berlin. Ent. Zeitschr., 31: 239; 1887. Cuba, Hispaniola, Puerto Rico.

Megistocera longipennis (Macq.); Dipt. exot., 1, pt. 1: 57; 1838 (*Tipula*). Cuba, Hispaniola, Puerto Rico.

LIMONIINAE

Limoniini

Limonia (*Limonia*) *basistylata* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4: 19–20; 1928. Jamaica.

Limonia (*Limonia*) *caribaea* sp. n.; this paper, conclusion. Cuba.

Limonia (*Limonia*) *hoffmani* Alex.; Journ. N. Y. Ent. Soc., 35: 265–266; 1927. Puerto Rico.

Limonia (*Limonia*) *jamaicensis* Alex.; *Ibid.*, 34: 223–224; 1926. Jamaica.

Limonia (*Discobola*) *gowdeyi* sp. n.; this paper, conclusion. Cuba, Jamaica.

Limonia (*Neolimnobia*) *diva* (Schin.); Novara Reise, Diptera, p. 46; 1868 (*Limnobia*). Cuba, Jamaica, Puerto Rico.

Limonia (*Dicranomyia*) *brevivena torrida* subsp. n.; this paper. Puerto Rico.

Limonia (*Dicranomyia*) *distans* (O. S.); Proc. Acad. Nat. Sci. Philadelphia, 1859: 211; Del., 1859. Puerto Rico.

Limonia (*Dicranomyia*) *divisa* Alex.; Philippine Journ. Sci., 40: 247; 1929. Hispaniola, Puerto Rico.

Limonia (*Dicranomyia*) *reticulata* (Alex.); Canad. Ent., 44: 334–335; 1912 (*Furcomyia*). Cuba.

Limonia (*Dicranomyia*) *trinitatis* Alex.; Journ. N. Y. Ent. Soc., 39: 110–111; 1931. Cuba.

Limonia (*Rhipidia*) *domestica* (O. S.); Proc. Acad. Nat. Sci. Philadelphia, 1859: 208; 1859 (*Rhipidia*). Cuba, Hispaniola, Jamaica, Puerto Rico.

Limonia (*Rhipidia*) *schwarzi* (Alex.); Bull. Brooklyn Ent. Soc., 8: 13–14; 1912 (*Rhipidia*). Cuba, Hispaniola, Jamaica.

Limonia (*Rhipidia*) *subcostalis* (Alex.); Proc. U. S. Nat. Mus., 60, art. 25: 3–4; 1922 (*Rhipidia*). Jamaica.

Limonia (*Geranomyia*) *antillarum* Alex.; Journ. N. Y. Ent. Soc., 37: 395–396; 1929. Cuba, Hispaniola, Jamaica, Puerto Rico.

Limonia (*Geranomyia*) *cinereinota* (Alex); Ent. News, 24: 407–408; 1913 (*Geranomyia*). Hispaniola, Puerto Rico.

Limonia (*Geranomyia*) *cubana* Alex.; Journ. N.Y. Ent. Soc., 37: 396–397; 1929. Cuba.

Limonia (Geranomyia) domingensis (Alex.); Proc. Acad. Nat. Sci. Philadelphia, 1916: 490–491; 1916 (*Geranomyia*). See *L.* (*G.*) *cinereinota* (Alex.).

Limonia (Geranomyia) intermedia (Walk.); List Diptera Brit. Mus., 1: 47; 1848. (*Limnobia*). Jamaica.

Limonia (Geranomyia) myersiana Alex.; Journ. N. Y. Ent. Soc., 37: 397–398; 1929. Cuba.

Limonia (Geranomyia) rostrata (Say), Antillean references erroneous, see *L.* (*G.*) *antillarum* Alex.

Limonia (Geranomyia) rufescens (Lw.); Linnaea Ent., 5: 396; 1851 (*Aporosa*). Puerto Rico.

Limonia (Geranomyia) subrecisa sp. n.; this paper. Puerto Rico.

Limonia (Geranomyia) subvirescens Alex.; Journ. N. Y. Ent. Soc., 38: 112; 1930. Cuba.

Limonia (Geranomyia) tibialis (Lw.); Linnaea Ent., 5: 397; 1851 (*Aporosa*). Cuba, Jamaica, Puerto Rico.

Limonia (Geranomyia) virescens (Lw.); Ibid., 5: 398; 1851 (*Aporosa*). Puerto Rico.

Helius (Helius) albitarsis (O. S.); Berlin. Ent. Zeitschr., 31: 184; 1887 (*Rhamphidia*). Cuba, Puerto Rico.

Helius (Helius) creper Alex.; Journ. N. Y. Ent. Soc., 34: 225; 1926. Jamaica.

Orimarga (Orimarga) cubensis sp. n.; this paper, conclusion. Cuba.

Orimarga (Diotrepha) flavicosta (Alex.); Dept. Sci. & Agr. Jamaica, Ent. Bull. 4: 23; 1928 (*Diotrepha*). Jamaica.

Orimarga (Diotrepha) mirabilis (O. S.); Cat. Dipt. N. Amer., Ed. 2; 27, 28; 1878 (*Diotrepha*).

Hexatomini

Epiphragma buscki Alex., Proc. U. S. Nat. Mus., 44: 540–541; 1913. Hispaniola.

Epiphragma cubensis Alex.; Journ. N. Y. Ent. Soc., 37: 403–404; 1929. Cuba.

Polymera (Polymera) geniculata Alex.; Insec. Inscit. Menst., 3: 106–107; 1915. Puerto Rico.

Polymera (Polymera) obscura Macq.; Dipt. exot., 1, pt. 1: 65; 1838. Cuba.

Shannonomyia brevicula Alex.; Journ. N. Y. Ent. Soc., 39: 113–114; 1931. Cuba.

Shannonomyia leonardi sp. n.; this paper. Puerto Rico.

Shannonomyia mesophragma Alex.; Journ. N. Y. Ent. Soc., 36: 52–53; 1928. Cuba.

Shannonomyia myersiana Alex.; *Ibid.*, 39: 112–1131; 1931. Jamaica.

Shannonomyia nacrea (Alex.); Proc. U. S. Nat. Mus., 44: 544–545; 1913 (*Limnophila*). Jamaica.

Shannonomyia triangularis (Alex.); Journ. N. Y. Ent. Soc., 35: 270; 1927 (*Pilaria*). Puerto Rico.

Atarba (*Atarba*) *angustipennis* Alex.; *Ibid.*, 36: 57; 1928. Cuba.

Hexatoma (*Eriocera*) *acuñai* (Alex.); *Ibid.*, 56–57; 1928 (*Eriocera*). Cuba.

Hexatoma (*Eriocera*) *ætherea* (Alex.); Ent. News, 27: 346; 1916 (*Eriocera*). Hispaniola.

Hexatoma (*Eriocera*) *bruneri* (Alex.); Journ. N. Y. Ent. Soc., 36: 55–56; 1928 (*Eriocera*). Cuba.

Hexatoma (*Eriocera*) *cramptoni* (Alex.); Dept. Sci. & Agr. Jamaica, Ent. Bull. 4: 23–24; 1928 (*Eriocera*). Jamaica.

Hexatoma (*Eriocera*) *cubensis* (Alex.); Journ. N. Y. Ent. Soc., 34: 229–230; 1926 (*Eriocera*). Cuba.

Hexatoma (*Eriocera*) *domingensis* (Alex.); Ent. News, 27: 346–347; 1916 (*Eriocera*). Hispaniola.

Hexatoma (*Eriocera*) *ocellifera* (Alex.); Insec. Inscit. Menst., 3: 104–106; 1915 (*Eriocera*). Puerto Rico.

Hexatoma (*Eriocera*) *trifasciata* (Röder); Stett. Ent. Zeitg., 56: 338; 1885 (*Eriocera*). Puerto Rico.

Elephantomyia westwoodi antillarum subsp. n.; this paper, conclusion. Cuba, Hispaniola.

Eriopterini

Gonomyia (*Progonomyia*) *slossonæ* Alex.; Proc. Acad. Nat. Sci. Philadelphia, 1914: 588–589; 1914; Ann. So. African Mus., 17: 152; 1917. Jamaica.

Gonomyia (*Gonomyia*) *brevicula* Alex., Journ. N. Y. Ent. Soc., 34: 225–226; 1926. Cuba.

Gonomyia (*Gonomyia*) *brevissima* Alex.; *Ibid.*, 34: 227; 1926. Cuba.

Gonomyia (*Ptilostena*) *angustissima* Alex.; *Ibid.*, 36: 57–58; 1928. Cuba.

Gonomyia (*Lipophleps*) *bicornuta* Alex.; *Ibid.*, 35: 276–277; 1927. Puerto Rico.

Gonomyia (*Lipophleps*) *bifiligera* sp. n.; this paper. Puerto Rico.

Gonomyia (*Lipophleps*) *cubana* Alex.; Journ. N. Y. Ent. Soc., 39: 120–121; 1931. Cuba.

Gonomyia (*Lipophleps*) *helophila* Alex.; Ent. News, 27: 343–345; 1916. Puerto Rico.

Gonomyia (*Lipophleps*) *pleuralis* (Will.); Trans. Ent. Soc. London, 1896: 289: 1896 (*Atarba*). Cuba, Jamaica, Puerto Rico.

Gonomyia (*Lipophleps*) *producta* Alex.; Journ. N. Y. Ent. Soc., 27: 139–140; 1919. Puerto Rico.

Gonomyia (*Lipophleps*) *puer* Alex.; Proc. U. S. Nat. Mus., 44: 506; 1913. Hispaniola, Jamaica.

Gonomyia (*Lipophleps*) *sandersi* Alex.; Journ. N. Y. Ent. Soc., 39: 121–122; 1931. Cuba.

Gonomyia (*Lipophleps*) *subterminalis* Alex.; *Ibid.*, 35: 275–276; 1927. Puerto Rico.

Teucholabis (*Teucholabis*) *bruneri* Alex.; *Ibid.*, 34: 227–228; 1928. Cuba.

Teucholabis (*Teucholabis*) *chalybeiventris* (Lw.); Wien. Entomol. Monatschr., 5: 33; 1861 (*Rhamphidia*). Cuba.

Teucholabis (*Teucholabis*) *gowdeyi* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4: 25–27; 1928. Jamaica.

Teucholabis (*Teucholabis*) *gowdeyi nigroterminalis* subsp. n.; this paper, conclusion. Cuba.

Teucholabis (*Teucholabis*) *myersi* Alex.; Journ. N. Y. Ent. Soc., 34: 228–229; 1928. Cuba.

Teucholabis (*Teucholabis*) *nebulipennis* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4: 27; 1928. Jamaica.

Teucholabis (*Teucholabis*) *nigrosignata* Alex.; Journ. N. Y. Ent. Soc., 39: 118–119; 1931. Cuba.

Trentepohlia (*Paramongoma*) *niveitarsis* (Alex.); Proc. U. S. Nat. Mus., 44: 501; 1913 (*Mongoma*). Jamaica, Puerto Rico.

Rhabdomastix (*Sacandaga*) *parva* (Alex.); *Ibid.*, 44: 508–509; 1913 (*Sacandaga*). Hispaniola, Jamaica.

Erioptera (*Mesocyphona*) *caloptera* Say; Journ. Acad. Nat. Sci. Philadelphia, 3: 17; 1823. Cuba, Puerto Rico.

Erioptera (*Mesocyphona*) *costalis* Alex.; Proc. U. S. Nat. Mus., 44: 517–518; 1913. Cuba.

Erioptera (*Mesocyphona*) *portoricensis* sp. n.; this paper. Puerto Rico.

Erioptera (*Empeda*) *nymphica* Alex.; Dept. Sci. & Agr. Jamaica, Ent. Bull. 4: 24–25; 1928. Jamaica.

Toxorhina (*Toxorhina*) *fragilis* Lw.; Linnaea Ent., 5: 401; 1851. Puerto Rico.

A few new species and subspecies of extra-Puerto Rican Tipulidae are described herewith in order to complete the record for the Greater Antilles.

Limonia (Limonia) caribaea sp. n. (Fig. 25)

General coloration yellow; mesonotal praescutum with three brownish black stripes; thoracic pleura with a broad dorsal black stripe, together with a reduced ventral area on the sternopleurite; legs chiefly black; wings faintly tinged with brownish, with a restricted darker brown pattern; *Rs* square and short-spurred at origin; *m-cu* longer than distal section of Cu_1; male hypopygium with the ventral dististyle bearing a single pale rostral spine; gonapophyses unusually powerful, blackened, the mesal apical lobe bidentate.

Male.—Length about 5.5 mm.; wing 6.2 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments elongate-oval, with long, unilaterally arranged verticils. Head with the frons and anterior vertex silvery gray, the posterior vertex darker.

Pronotum obscure yellow, with a narrow, dark, longitudinal line on either side. Mesonotal praescutum yellow, with three brownish black stripes that are all more or less confluent near their anterior ends; median stripe not reaching the anterior margin of sclerite and more or less split by a capillary pale vitta; posterior sclerites of mesonotum chiefly pale brown, the posterior border of the postnotal mediotergite darker, this being the end of a conspicuous black pleural stripe. Pleura yellow, with the stripe just described, together with a similar intense blackened area on the ventral sternopleurite. Halteres dark brown. Legs with the coxae and trochanters light yellow; femora dark brown, their bases restrictedly paler, the tips narrowly still darker brown; tibiae and tarsi black. Wings with a faint brownish tinge, the prearcular and costal regions more yellowish; a restricted dark brown pattern, as follows: Origin of *Rs*; fork of *Sc*; along cord and outer end of cell *1st* M_2; stigma; pale brown streaks in centers of cells R_1, R_3, R_4 and R_5; veins brown. Venation: Sc_1 long, ending just beyond midlength of *Rs*, Sc_2 at its tip; *Rs* nearly square and weakly spurred at origin; free tip of Sc_2 and R_2 in transverse aligment; *m-cu* at fork of *M*, about one-half longer than the distal section of Cu_1.

Abdominal segments dimidiate, pale yellow basally, the apical half and narrower lateral margins dark brown, the amount of dark increasing on the outer segments. Male hypopygium (Fig. 25) of somewhat remarkable structure. Ninth tergite transverse, the caudal margin with two rounded lobes. Ventro-mesal lobe of basistyle very large. Dorsal dististyle a slender, nearly straight rod, before the apex a little widened and gently curved, the tip acute. Ventral dististyle smaller than the basistyle, white, deeply divided by a dorsal notch in which the dorsal dististyle rests; rostral prolongation a pale, compressed blade, at its base with a setiferous area that includes a single pale rostral spine. Gonapophyses very large and powerfully constructed, the mesal apical lobe stout, bidentate. Aedeagus broad, each outer apical angle bearing a small lobe.

Habitat.—Cuba.

Holotype, ♂, San Blás, Santa Clara, Trinidad Mts., altitude about 700 feet, May 5, 1932 (Bruner and Otero).

This very distinct *Limonia* requires no comparison with any described members of the subgenus. The peculiar structure of the hypopygium is quite different from any of the described Neotropical species.

Limonia (Discobola) gowdeyi sp. n. (Fig. 26)

General coloration yellow and black; antennal flagellum black; apices of knobs of halteres blackened; tibiae narrowly blackened at bases; wings the usual ocellate pattern arranged in five more or less complete fasciae.

Male.—Length about 10 mm.; wing 13 mm.

Female.—Length about 9 mm.; wing 9.5 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments (female) narrowly subcordate, with short apical pedicels; terminal segment more slender, about one-third longer than the penultimate. Head behind light brown, more grayish in front.

Pronotum yellowish. Mesonotal praescutum obscure yellow, with five brown lines on posterior half, these including the posterior ends of three more or less confluent discal stripes, together with the darker lateral margins of the sclerite; scutum yellow, each lobe with a ring-like brown area; scutellum black, obscure yellow medially at base; postnotal mediotergite chiefly blackened. Pleura greenish yellow, handsomely variegated with black, including the middle coxae, sternopleurite and ventral half of anepisternum, from which last-named a black band extends caudad across the pteropleurite and pleurotergite to the postnotal mediotergite; a narrower incomplete stripe extends caudad and dorsad across the meral region, nearly if not quite attaining the haltere; a linear black dash on margin of dorso-pleural membrane. Halteres chiefly black, the base of stem and base of knob pale. Legs with the coxae yellow, the mid-coxae black, as described: trochanters yellow; femora yellow, slightly darkened outwardly, the broad apex abruptly clear light yellow, enclosing a narrow subterminal black ring that is a little wider than the terminal yellow annulus and subequal to the basal pale annulus; tibiae obscure yellow, the proximal end just beyond base and the apex narrowly and subequally blackened; terminal tarsal segments passing into dark brown. Wings cream-yellow, more saturated at base and in costal region; extreme base of wing darkened; the usual ocellate pattern is arranged as five crossbands, complete or nearly so, the first at base and before the supernumerary crossvein, the latter lying in the first pale interspace; second dark fascia broad, with the origin of *Rs* as a center; third fascia along cord; fourth composed of two contiguous ocelli, with R_2 and outer end of cell *1st* M_2 as centers; outermost fascia at wing-apex, broken; the three outer interspaces are occupied by dark posterior marginal spots at ends of veins *1st A*, Cu_1 and M_4, respectively; veins yellow, brown in the clouded areas. Venation: Cell *1st* M_2 long-rectangular, the second and third sections of M_{1+2} subequal; *m-cu* just beyond fork of *M*.

Abdominal tergites dimidiate, the bases blackened, the apices yellow; on proximal segments, the black areas are more restricted to the lateral portions, on the third to seventh segments the black bands are continuous and gradually increasing in area on the outer sclerites; genital segments obscure yellow.

The allotype male is much larger than the type female but seems unquestionably to belong here. The dark band-like fasciae of the wings are more broken, with more extensive pale centers, yet retain the five-banded appearance of the type. Male hypopygium (Fig. 26) agreeing in its general features with *L. (D.) argus* (Say) but differing in several regards. The ventral dististyle is much longer, with the outer lobe produced; rostral spines at the base of the prolongation but not arising in hyaline membrane, as in *argus*; apex of the prolon-

gation extended into a small sclerotized point. Lobe on mesal face of basistyle very extensive.

Habitat.—Cuba, Jamaica.

Holotype, ♀, Cinchona, Blue Mts., Jamaica, June 1889 (W. Fawcett); Brit. Mus. Access. No. 89–80. Allotype, ♂, San Blás, Santa Clara, Trinidad Mts., Cuba, altitude 700 feet, December 4, 1931 (G. C. Rowe). Paratopotype, one specimen of doubtful sex, from the type-locality, August 2, 1923 (C. C. Gowdey).

The type and paratype are in the British Museum of Natural History, the allotype in the writer's collection.

Limonia (*Discobola*) *gowdeyi* is named in honor of the late Mr. C. C. Gowdey, former Entomologist for Jamaica. The species is quite distinct from all other described members of *Discobola,* being closest to *argus,* yet differing in numerous features of coloration, wing-pattern and structure of the male hypopygium. The discovery of this subgenus in the Antilles far to the south of its known range was a highly significant one.

Orimarga (Orimarga) cubensis sp. n.

General coloration black; lateral margin of praescutum and a slightly wider stripe on ventral pleura silvery; legs black; wings long-petiolate basally, nearly hyaline; R_1 meeting R_2 at an obtuse angle, with a short spur of R_{1+2} at the point of angulation; *m-cu* lying far distad, shortly before the level of the outer end of *Rs*; vein *2nd A* short.

Male.—Length about 8 mm.; wing 5 mm.

Rostrum and palpi black. Antennae broken. Head black, with a light gray pruinosity.

Pronotum and mesonotum black, the praescutum narrowly lined laterally with silvery. Pleura brown, with a ventral silvery stripe that is a little wider than the praescutal vitta. Halteres broken. Legs with the coxae and trochanters horn-colored; remainder of legs black, the extreme femoral bases paler. Wings with a long basal petiole, nearly hyaline; veins dark brown. Costal fringe (male) relatively long and dense; macrotrichia of veins beyond cord long and abundant. Venation: Sc_1 ending opposite origin of *Rs*; free tip of Sc_2 preserved; R_1 meeting R_2 at an obtuse angle, R_{1+2} being represented at this point of angulation by a tiny spur; vein M_3 a little less than three times M_{3+4}; *m-cu* lying far distad, about opposite the outer end of *Rs* and about one-third that section beyond it; vein *2nd A* unusually short.

Abdominal tergites brownish black, narrowly bordered laterally by yellowish; tip of abdomen broken.

Habitat.—Cuba.

Holotype, ♂, Sierra Rangel, Pinar del Río, August 28, 1929 (Acuña and Bruner).

The long-petiolate wings readily separate this fly from all allies,

except *O.* (*O.*) *niveitarsis* Alex. (Panama), which is readily told by the white tarsi and position of *m-cu* opposite the origin of *Rs*. The general features of venation are somewhat as in *O.* (*O.*) *wetmorei* Alex. (southern Florida) but the details are quite distinct, especially the narrow cell *2nd A* and the distal position of *m-cu*.

Elephantomyia westwoodi antillarum subsp. n. (Fig. 13)

Male.—Length, excluding rostrum, about 8.5—9.5 mm.; wing 7—8.5 mm.; rostrum about 8—8.5 mm.

Similar to typical *westwoodi* O. S., differing as follows: Antennae more uniformly infuscated. Mesonotum not or scarcely darkened medially; ventral sternopleurite restrictedly blackened. Wing-apex distinctly infumed. Abdomen almost entirely yellow, the lateral portion of tergites darkened; subterminal segment infuscated but less so than in *westwoodi*; sternites three and four with a median brown spot before caudal margin. Male hypopygium with the outer dististyle conspicuously bidentate at apex, the outer spine straighter and more slender than the curved axial or inner spine.

Habitat.—Cuba, Hispaniola.

Holotype, ♂, Buenos Aires, Trinidad Mts., Cuba, altitude 2350–2800 feet, May 3–4, 1931 (Bruner, Acuña and Otero). Paratopotypes, 2 ♂ ♂. I have also seen this from Hispaniola (Haití), taken by Dr. John G. Myers.

The relationship of the present fly to *westwoodi* seems best expressed by a trinomial.

Teucholabis (Teucholabis) gowdeyi nigroterminalis subsp. n.

Male.—Length 10—11 mm.; wing 8–85 mm.

Close to typical *gowdeyi* Alex., (Jamaica), differing most evidently in the broad black apices of all the femora. In the typical form, the corresponding markings are much narrower, dark brown, and are subterminal in position.

Habitat.—Cuba.

Holotype, ♂, Sierra Rangel, Pinar del Rio, January 27–30, 1931 (Acuña and Otero). Paratypes, 1 ♂, Buenos Aires, Trinidad Mts., altitude 2350–2800 feet, May 3, 1932 (Bruner and Otero); 1 badly damaged ♂, San Blás, Trinidad Mts. (G. C. Rowe).

Explanation of Plates

PLATE XLIII

Fig. 1. *Megistocera longipennis* (Macq.); venation.
Fig. 2. *Brachypremna unicolor* O. S.; venation.
Fig. 3. *Dolichopeza* (*Megistomastix*) *portoricensis* (Alex.); venation.
Fig. 4. *Limonia* (*Limonia*) *hoffmani* Alex.; venation.
Fig. 5. *Helius* (*Helius*) *albitarsis* (O. S.); venation.

PLATE XLIV

Fig. 6. *Limonia* (*Limonia*) *hoffmani* Alex.; male hypopygium.
Fig. 7. *Limonia* (*Dicranomyia*) *distans* (O.S.); male hypopygium.
Fig. 8. *Limonia* (*Dicranomyia*) *divisa* Alex.; male hypopygium.

Symbols: a = ædeagus; b = basistyle; d = dististyle; dd = dorsal dististyle; g = gonapophysis; t = tergite; vd = ventral dististyle.

PLATE XLV

Fig. 9. *Orimarga* (*Diotrepha*) *mirabilis* (O. S.); venation.
Fig. 10. *Polymera* (*Polymera*) *geniculata* Alex.; venation.
Fig. 11. *Shannonomyia leonardi* sp. n.; venation.
Fig. 12. *Hexatoma* (*Eriocera*) *cubensis* (Alex.); venation.
Fig. 13. *Elephantomyia westwoodi antillarum* subsp. n.; venation.

PLATE XLVI

Fig. 14. *Epiphragma cubensis* Alex.; venation.

Symbols: A = Anal veins; C = Costa; Cu = Cubitus; M = Media; R = Radius; Rs = Radial sector.

PLATE XLVII

Fig. 15. *Gonomyia* (*Lipophleps*) *bifiligera* sp. n.; venation.
Fig. 16 *Teucholabis* (*Teucholabis*) *nigrosignata* Alex.; venation.
Fig. 17. *Trentepohlia* (*Paramongoma*) *niveitarsis* (Alex.); venation.
Fig. 18. *Erioptera* (*Mesocyphona*) *portoricensis* sp. n.; venation.
Fig. 19. *Toxorhina* (*Toxorhina*) *centralis* Alex.; venation.

PLATE XLVIII

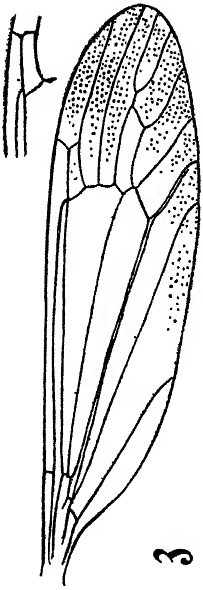
Fig. 20. *Gonomyia* (*Lipophleps*) *helophila* Alex.; male hypopygium.
Fig. 21. *Gonomyia* (*Lipophleps*) *bifiligera* sp. n.; male hypopygium.
Fig. 22. *Gonomyia* (*Lipophleps*) *bicornuta* Alex.; male hypopygium.
Fig. 23. *Gonomyia* (*Lipophleps*) *producta* Alex.; male hypopygium.
Fig. 24. *Gonomyia* (*Lipophleps*) *subterminalis* Alex.; male hypopygium.

Symbols: b = basistyle; d = dististyle; p = phallosome.

Fig. 25. *Limonia* (*Limonia*) *caribæa* sp. n.; male hypopygium.
Fig. 26. *Limonia* (*Discobola*) *gowdeyi* sp. n.; male hypopygium.

Symbols: a = ædeagus; b = basistyle; dd = dorsal dististyle; g = gonapophysis; t = tergite; vd = ventral dististyle.

PLATE XLIII



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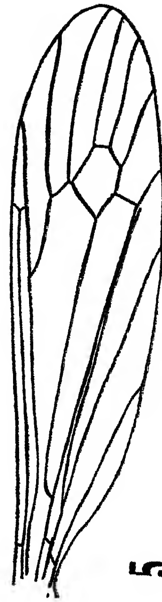

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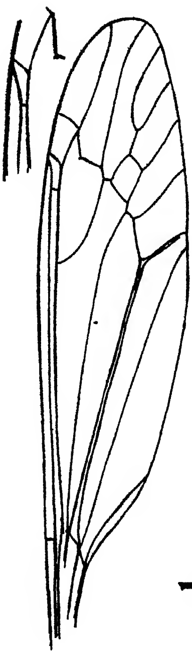

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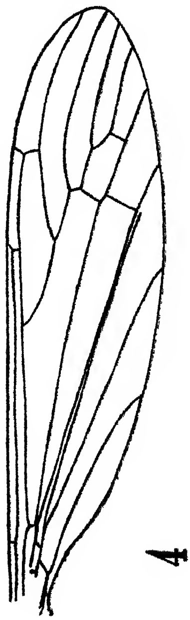

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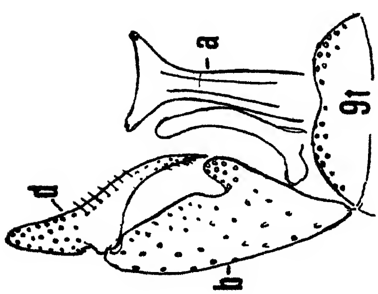
PLATE XLIV



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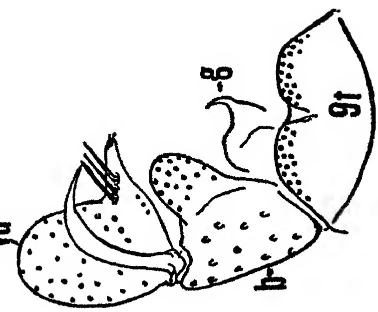

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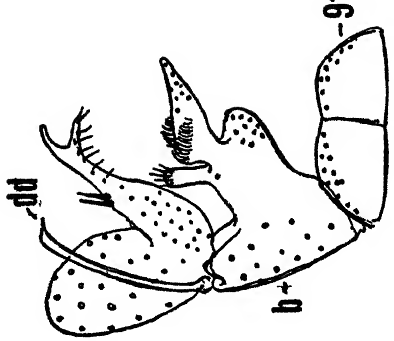

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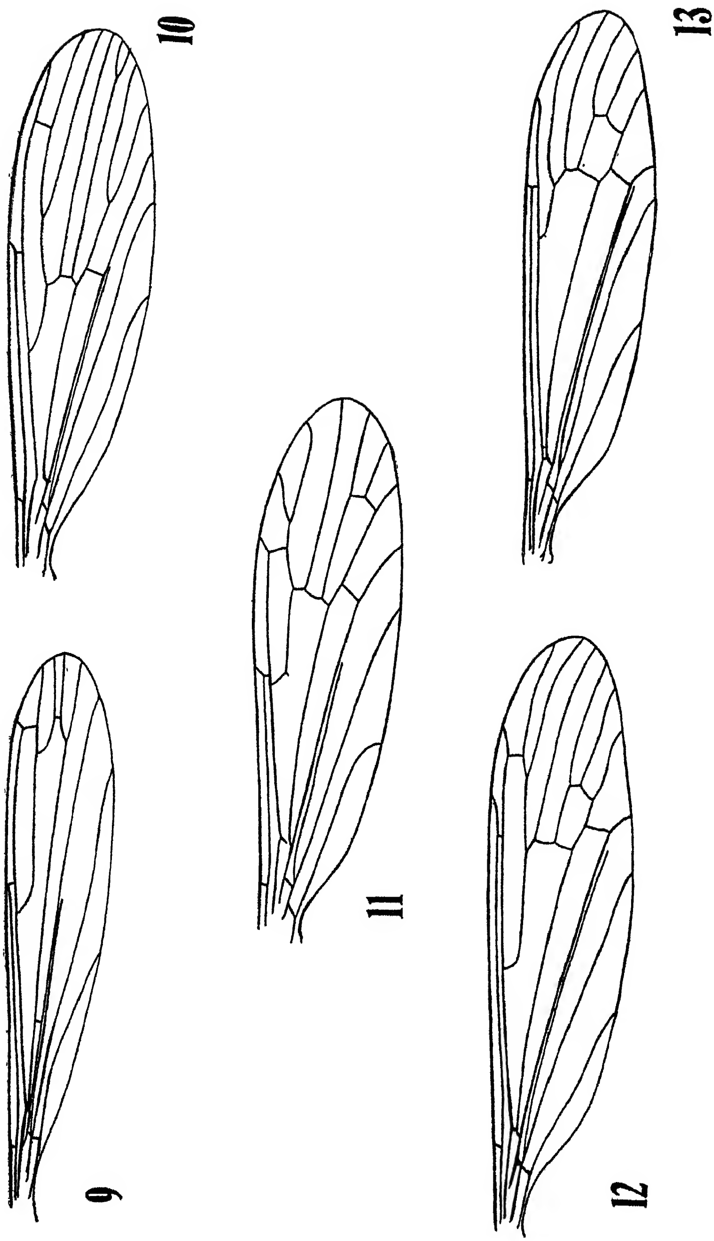
PLATE XLV



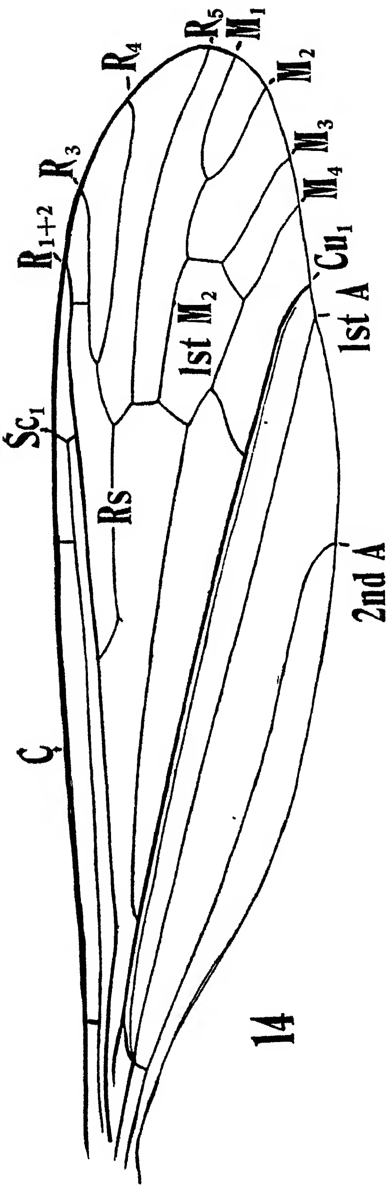


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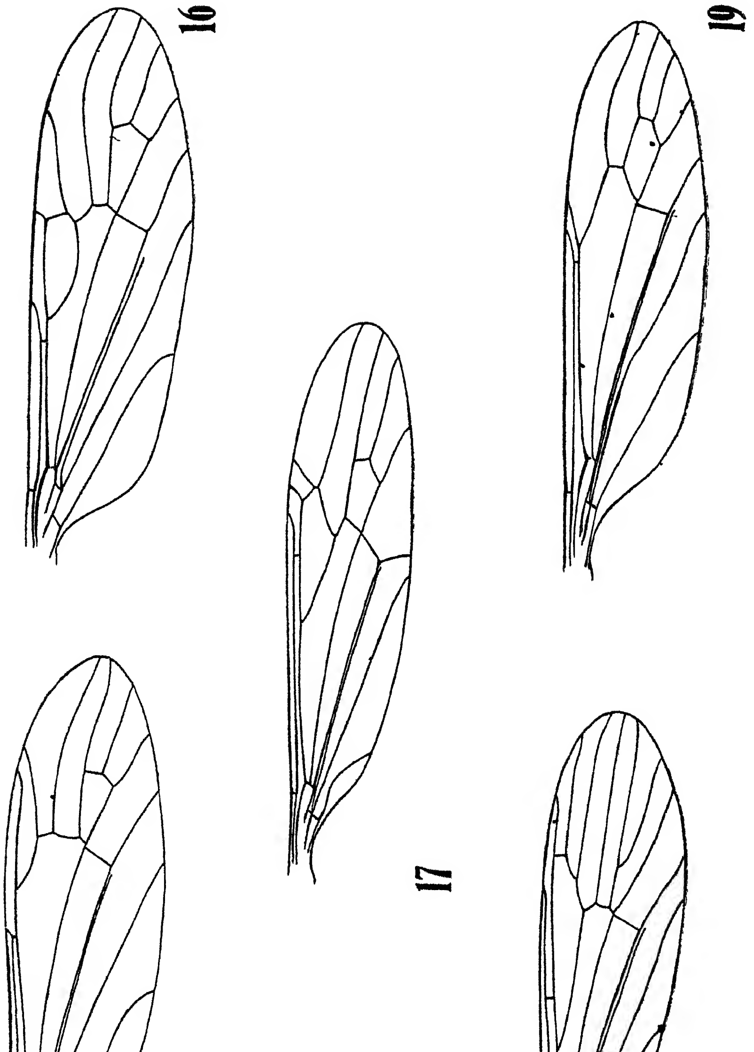
PLATE XLVII



FUSARIUM DISEASE OF COFFEE IN COSTA RICA *

By C. Picado T.

The literature on Fusarium diseases of coffee throughout the world is very meagre. Delacroix (4)[1] gives *Fusarium coffeicola* as mildly attacking the leaves of coffee in Africa. Averna Saccá (2) reports the presence of *F. pallens* in the roots of coffee plants attacked by *Rosellinia* and in some nurseries attacked by *Colletotrichum* sp. in Brazil. It is also found in root lesions produced by nematodes. He reports *F. coffeicola* producing a blackening of the berries and causing their premature falling in Brazil. Fawcett (5) reports a *Fusarium* attacking coffee plants in Puerto Rico, destroying the bark at the base of the stem. He believes the fungus follows injuries produced by implements and insects. The disease may be reproduced by inoculating plants with pieces of diseased tissues. Arndt and Dozier (1) report *F. martii* following injury by the coffee cricket. As a result of the attack, the cortex becomes black and the trees shed their leaves. A consideration of the above facts establishes the malady under discussion as a new disease caused by an undescribed fungus.

HISTORY

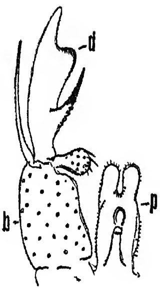
It is very probable that the disease under discussion is none other than the one called "Chasparria" by our farmers. For several years it has been present in the coffee plantations, but has failed to attract attention because its presence was limited to a few scattered plants. For the last two years, the disease has been decidely on the increase and suddenly, most unexpectedly, a severe outbreak occurred after the trees had withstood fairly well a long period of drought during the years 1929 and 1930. The rainfall for the last five years was as follows:

	Meters	Inches
1927	2. 233	87. 91
1928	2. 295	90. 35
1929	1. 775	69. 88
1930	1. 153	45. 39
1931 (11 months only)	2. 420	95. 27

Following the beginning of the rainy season of this year (1931)

* A contribution from the laboratory of the hospital.

[1] Numbers in parenthesis refer to literature cited.



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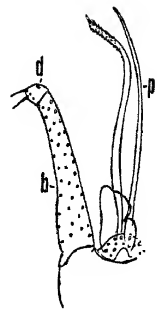

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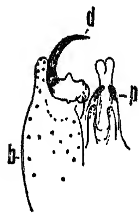

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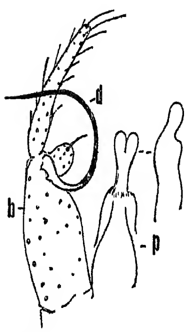

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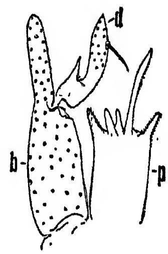

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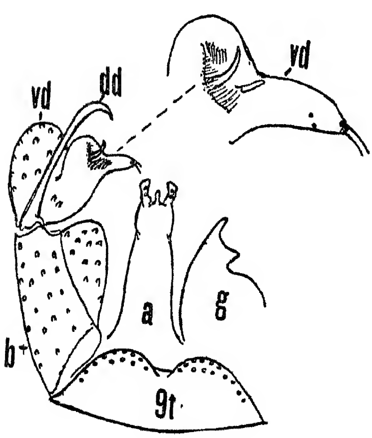

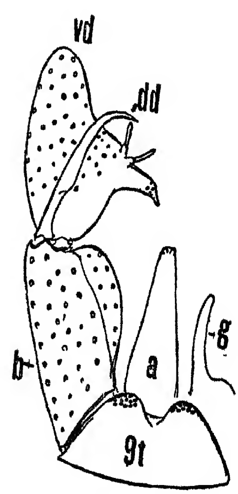

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the trees, instead of initiating new growth, shed their leaves and the new shoots dried up and blackened. Whole plantations, many acres in extent, were completely defoliated.

The disease seems to have had its beginning in the province of Heredia and gradually progressed towards the East, apparently following the direction of the wind. Later, the disease appeared to some extent in Alajuela and more recently, we have seen isolated cases of it about 15 kilometers from the center of the infestation, irrespective of the kind of soil.

LOSSES

An accurate estimate of the losses as a result of the disease is, at present, impossible. Although many of the attacked plants died, many more recovered but made an abnormal growth. In some places, the disease began before the start of the rainy season and when the berries were maturing. As a result, the yield this year will be greatly reduced. Diseased plants, although recovering, will yield less each successive year until the crop will fail to pay expenses. The culture of coffee will then be abandoned.

Expert growers estimate that the crop in the affected areas will be reduced by 25 per cent. At present prices, this means a gross loss of about $100,000.

SYMPTOMS

During the course of the disease both internal and external symptoms are produced. The external symptoms differ depending on whether the disease develops in the spring or autumn.

In the first case, the plants are attacked severally and the course of the disease is more rapid. With the first rains of the spring healthy trees start their new growth and begin to flower. The heavy rains follow these early showers from two to four weeks later; and with them, active vegetative development ensues. Diseased plants, however, fail to renew active growth with the establishment of the rainy season proper and instead, the young, tender shoots produced with the early rains die and become charcoal black (Fig. 1). In some cases the trees begin to shed their leaves, the new shoots stop growing without blackening, but produce abnormal leaves and branches. New plants pruned half a meter from the ground produce new shoots but these are abnormal. Diseased, abandoned fields have plants with their tops dead but with a proliferation of thin, slender, unproductive branches underneath.

In the autumn, the plants are attacked when vegetative growth

is slow and the berries begin to ripen. There is not the rapid defoliation that characterizes the spring symptoms, but instead the disease appears gradually and its course is much delayed (Fig. 4). The invasion, however, is persistent and finally the fruiting branches are destroyed. The berries from such branches are seedless and only those fruits that mature before the branches begin to dry have a normal appearance.

Besides these obvious symptoms, there are others more difficult to detect such as the splitting of the cortex of green branches; a gradual yellowing of the leaves, beginning along the veins, prior to their being shed; dry, sunken areas of cortex tissue and black necrotic are formed in dead branches.

If the cortex of a diseased plant is carefully peeled off, black streaks or filaments running from the roots upwards are evident along the vascular tissue. Sometimes these streaks extend to the medulary rays and the pith. The cortex from such plants is easily removed around the lower part of the stem and the upper part of the root. A carefully pulled plant will have a very large number of its rootlets partially desintegrated, blackened and sometimes totally necrotic. Often the injury extends to the primary and secondary roots.

ETIOLOGY

The disease is produced by *Fusarium anisophilum*, n. sp. Its perfect stage is *Nectaria anisophila*, n. sp. which develops in diseased shade trees.

ISOLATION OF THE FUNGUS

The fungus has been isolated easily by aseptic plantings of pieces of infected roots or bark on sugar agar.[1] From this medium the fungus has been systematically transferred to Richard's [2] solution for further growth. It has also been grown on rice (autoclaved in an equal volume of water), potato, carrot, kidney bean and autoclaved coconut water previously boiled and filtered.

CULTURAL CHARACTERISTICS

On sugar agar initial cultures 3–5 days old always produce a light rose color which soon changes. Subcultures from these are almost white or orange, intense vermillion or violaceous red. After the second day, unicellular conidia $3\,\mu \times 6\,\mu$ are produced, especially

[1] Sugar Agar: Sugar-cane syrup (Panela) 10 per cent; Peptone 1 per cent; Ammonium phosphate 0.5 per cent; Agar-Agar 3 per cent.

[2] Richard's solution: KNO_3 10 grs.; KH_2PO_4 5 grs.; $MgSO_4$ 2.5 grs.; $FeCl_3$ 0.2 Mgms.; Sugar Candy 50 grs.; H_2O 1000 c.c.

so in the red colonies. In the white or orange colonies are found long, thin, 2, 3 or 5 septate conidia with curved ends, measuring $4\,\mu \times 40\,\mu$.

Since the production of a given color can not be safely regarded as an index to the unity of the species under study, various tests were made to elucidate this point. The various subcultures were grown on Richard's solution to which 1 c.c. of a 1 per cent solution of caffeine sulphate had been added for each 100 c.c. of the medium. All the cultures, irrespective of their original color, produced salmon colored colonies. In a few weeks both micro and macroconidia were produced. When transferred to slants macroconidia were produced in 6 days even by the less sporulating types. The presence of caffeine was equally antiseptic to all the subcultures and the same thing may be said of the presence of lactic acid.

Old mycelium grown in Richard's solution when ground gives an acrid odor. Allowed to oxidize by exposure to the air the odor soon recalls that emitted by bed bugs. *F. cubense,* a species very similar to *F. anisophilum,* specially when grown on rice, when similarly treated produces an agreeable fruit-like odor.

Successive plantings in liquid media with the same fungus were found to inhibit the growth if the same species was repeatedly used as the inoculum. To this effect, the apparently different sub-cultures of *F. anisophilum* and also *F. cubense* were grown in Richard's solution in flasks, so as to expose a large surface of the medium to the growth of the fungus. Every two weeks the solution was filtered and replanted with its corresponding fungus. After the third planting, the medium was no longer favorable for the growth of the fungus even when a proportionate amount of the nutritive salts were supplied to each flask. The different subcultures of *F. anisophilum,* irrespective of their color or characteristics, when interplanted in the culture media on which they have been growing failed to develop, but when any one of them was planted on the fluid medium where *F. cubense* has been growing, they made very good growth. When *F. cubense* was planted in its own culture medium it failed to grow, but when planted in any of the media where the various strains of *F. anisophilum* had been growing it also made very good growth.

This method of specific vaccination of the liquid medium has not been used to differentiate the imperfect forms of fungi, but we look upon it as more promising than the present serological tests.

Within the limits of our cultures *in vitrio* we feel justified in establishing the unity of the species for the following reasons: (1) Mutation or loss of color; sometimes in the same agar slant. (2) Same coloration in the presence of caffeine. (3) Production of mi-

croconidia and macroconidia irrespective of the original inoculum. (4) Equal sensibility towards antiseptics. (5) Production of same odor producing substances, and (6) same reaction towards vaccinated media.

FRUITING BODIES

After diseased plants have lost their leaves and their branches begin to dry, small epidermic vesicles are found, particularly behind the leaf scar, which contain the sporodochia. These produce either macroconidia or microconidia. Generally, the conidiophores have four segments. If these are thick and short, they will develop into the microconidiophore at the end of which one microconidia usually is present, although rarely there may be two (Fig. 9 *a*). Sometimes the conidiophores are not so uniform and divide into two or three branches.

With *F. cubense,* microconidia and macroconidia are successively produced from the same sporodochium; while in *F. anisophilium* the conidiophoresare differentiated into either one or the other type of conidia.

The microconidia are ovoid, uniloculated, and average $3\,\mu \times 7\,\mu$ in size. The macroconidia are in general almost straight, with the ends bent, and average $4\,\mu \times 40\,\mu$. Some are 6 or 7 septate and measure $7\,\mu \times 60\,\mu$. Intermediate forms with one septum, measuring $4\,\mu \times 20\,\mu$ are also found.

The conidiophores are not always produced immediately, under the epidermis; frequently they are found beneath the cortex directly on the vascular tissue.

Intercalary chlamydospores, spherical and rarely elliptical, are generally formed in sugar agar plates and old carrot slants. When grown on kidney beans, macroconidia are always produced within 8 days irrespective of the type of inoculum used, the medium on which it has been growing previously or its ability to produce microconidia in such medium.

The easiest procedure to obtain conidia is by making an emulsion of the finely ground mycellium in sterile water and inmersing young coffee shoots in it. Within two or three weeks conidiophores bearing conidia with their silky paraphyses are abundantly produced.

THE PERFECT STAGE

The perfect stage of *F. anisophilum* was found in the lesions of diseased shade trees. We have classified it as *Nectria anisophila* n. sp. Its description is as follows:

Perithecia isolated or in colonies, globular, simple or with projections arising from the vesicles covering their walls, deep orange almost vermellion in color measuring 270 μ — 340 μ in diameter; asci cylindrical 70 μ — 90 μ × 12 μ — 14 μ; spores 8, monoseptate, usually incline, uniseriate, 14–15 μ × 6–7 μ, hyaline, smooth, elliptic or fusoid; paraphyses filiform, branching, twisted (Fig. 9).

This species differs from *N. inga* Chardon, (**3**), by having larger perithecia and by the presence of branched and twisted paraphyses. On germination *N. inga* failed to produce the form *F. anisophilum*. The codinial stage of *N. anisophila* reproduced in all its details the cultural and pathogenic reaction produced by *F. anisophilum*. Ascospores cultures of *N. anisophila* are able to reproduce the perfect stage when grown on coffee shoots in a moist chamber provided the source of the ascospore has been *Inga* trees and not coffee trees. Subcultures made from said fungus growing on coffee shoots fail to produce the perfect stage when reinoculated into coffee shoots in a moist chamber. *By passing thru the coffee plant as a host the fungus losses its ability to produce its perfect stage.* This explains our failure to obtain the ascigerous stage when making cultures of the fungus isolated from diseased coffee plants. The Nectria form may be obtained from any of the cultures isolated from coffee by growing them on branches of *Inga* in a moist chamber.

SECRETIONS OF THE FUNGUS

In order to study the hosts reaction towards the secretions of the fungus, cultures of *F. anisophilum* were grown in 500 cc of Richard's solution in one liter flasks. *F. cubense* was similary grown for use as a check. At the end of one month the culture fluids were filtered and diluted in various proportions. Young coffee shoots and 12 day old kidney bean plants cut under water were inmersed in the various solutions. In every case, corresponding checks were made by heating the various fluids for 5 minutes at 100°C.

The results warrant the following conclusions:

1. The fungus secretes a thermolable diastase capable of digesting the tissues of coffee or kidney beans in contact with it.

2. There is a blackening of the coffee tissues immersed in the fluid.

3. Both of these reactions are greatly inhibited by heating the fluids.

Similar tests were made using emulsions of the ground mycelium. Coffee branches immersed in this fluid without previous heating reacted in a similar way as diseased plants in the field; the leaves

wilted, became clorotic beginning at the veins, soon dropped and the branches died. *There is, therefore, a toxic action effective at a distance capable of inducing a chlorotic condition and shedding of the leaves.*

INOCULATIONS

Direct, soil and field inoculations were made. Direct inoculations of the leaves and branches were never successful; the inoculum used was a sporulating culture a few days old. Inoculations into thick roots of old trees also failed and the wounds healed normally.

In pots, with sterilized soil, which was inoculated with the fungus, plants in the butterfly stage, i. e., with only the cotyledons expanded; and plants one year old having six pairs of leaves were planted. Three plants were set in each pot, 2 were left uninjured and the third one was punctured in the root crown. Checks were similarly treated. The uninjured plants in the butterfly stage did not seem to contract the disease but the injured ones are greatly retarded in their growth, a reaction not evident in the check plants (Fig. 4). On the other hand, the one year old plants were immediately attacked by the fungus which destroyed the cortex from the base of the stem upwards (Fig. 5), whether or not punctured at the time of planting.

The resistance of the small seedlings towards the disease might be explained on the basis of the antiseptic action of the caffeine towards the fungus, since they contain practically all the alkaloid present in the seed.

Keeping inoculated plants at a temperature of 18°–22°C. seems to greatly diminish the activity of the pathogene or increase the resistance of the plant to its invasion. The year old plants in inoculated soil may, at that temperature, remain apparently healthy for at least 5 months. The same plants taken outdoors (45°C. under sunlight) begin to defoliate in about 5 weeks and by that time the cortex of the branches has begun to dry. They behave as if inoculated at the time of transferring them to the open.

In our experimental plot, 25 two year old plants brought from areas not infected were set in 5 rows, 2½ meters apart and inoculated as follows: The middle row was inoculated at the time of planting with pieces of diseased roots around each ball of earth. The remaining rows were allowed to establish themselves and two weeks later the soil around them was inoculated with cultures of the fungus. One row was not inoculated to serve not as an absolute but as a relative check. At the end of a month, the row inoculated at the time of planting had 15 branches completely defoliated and begin-

ning to blacken while the remaining 4 rows had a total of 16 defoliated branches. Two weeks later the row inoculated at the time of planting had 18 defoliated branches; those inoculated fifteen days later had 7, 10 and 16 defoliated branches respectively and the check row had only 4 defoliated branches. By this time the fungus had spread through the soil to the check row and could be isolated from the soil around it. At the end of two months the plants were showing typical symptoms of the disease; the stems had gray colored cracks surrounded by black tissue (Fig. 6) and the new shoots in the base of the branches died back, showing that although defoliation occurs from the lower branches towards the top ones, death follows afterwards from the top towards the base.

Proliferation of rootlets followed the destruction of the roots by the fungus (Fig. 7). The fungus was recovered from these disease roots and sporodochia were present in the defoliated branches.

As previously stated inoculations performed in the thick roots of old trees failed to reproduce the disease for 5 months and the inoculum failed to enter the host through the injury. After this period, however, plants were infected. A close examination revealed that the inoculum spread through the soil and later attacked the young, fine roots.

OTHER HOSTS

Kidney Beans.—By an accidental contamination in the laboratory this legume was found to be susceptible to *F. anisophilum*. Repeated inoculations demonstrated that the black kidney beans were resistant, but the white and red varieties highly susceptible. The roots were destroyed and cankers developed at the base of the stem as a result of the infection, but the vascular tissue was not penetrated (Fig. 8).

This plant was used in the field as an index host to study the spread of the fungus in the soil. It was found that in two weeks the fungus spread 2½ meters through the soil.

Lima Beans.—A small planting of this legume growing near our inoculated plots was attacked also by the fungus.

Flame Tree (*Ponciana regia*).—A natural case of the disease has been found on this tree under which diseased wood was piled. The fungus *F. anisophilum* was isolated from the diseased tissues.

Shade Trees.—In view of the fact that most coffee shade trees are legumes, a close examination of them was made. Lesions and symptoms similar to the ones produced by the coffee disease were found. Tissue plantings of affected roots and branches gave cultures of *F. anisophilum*.

Gliricidia maculata, Inga sp., and *Erythrina* sp. were found to contract the disease. The perfect stage of the fungus, *Nectria anisophila* was found in the dead branches of these hosts.

CONTROL

Mechanism of Infection.—Taking into consideration the prolonged periods of drought and the fact that the disease appeared within a a few kilometers of the capital at a time when the increased use of electricity for heating and as a substitute for other sources of fuel, brought about a decrease in the price of timber, we are led to conceive the origin of this disease in the following manner. In the old days, it was a regular practice among coffee growers to prune their coffee shrubs and shade trees, and to sell the waste wood so obtained, there being a ready market and quite a big demand for it. This demand has fallen off and there is no market for this wood. The practice of pruning is gradually disappearing and those growers who still practice it, pile up the twigs and branches either in the coffee plantations or in places nearby. Every one of these piles has become a breeding place for millions of *Nectria* which have scattered and invaded the surrounding leguminous trees and coffee shrubs. The spread of the disease following the light rains, and its increased virulence during the rainy season is thus explained.

Once the soil becomes infested, the fungus attacks the small rootlets and the fate of the plant depends upon the severity of the infection and upon the fertility of the soil. In those cases where the infection is severe, even though the plant produces new roots the fungus will make much headway, and the plant will become seriously affected. In poor soils where root development is checked, even slight infections will prove disastrous to the plantation. On the other hand, in good soils the plants will tolerate and withstand a slight infection.

Defoliation may be ascribed to two reasons: Not enough water to supply the demands of transpiration and photosynthesis, and the toxic action of the enzymes or catabolic secretions of the organism. Coffee seedlings planted in pots filled with inoculated soil thrive very well for some months at least, provided they are kept under cover, in a humid atmosphere, and are watered regularly. These seedlings soon loose their leaves after they are planted in the open in spite of our efforts to gradually accustom them to the effects of direct sunlight. The roots of those plants which are grown under shade, and

of those grown without shade are injured. Plants grown in pots continued to live although the dead tissue in the cortex extended as far as the woody cylinder. They continue to live even if the bark at the base of the stalk is stripped off.

The presence of the fungus in the branches is due to secondary infection. In spite of repeated inoculations and spores sprayed on the branches of healthy plants, we have not been able to produce the disease. Everything tends to prove that initial infection takes place through the roots. Cultures from root material have always yielded the *Fusarium anisophilum* only, while culture from branch material show other genera of fungi also.

Some years ago, several *Poinciana Regia* tres were imported from the island of Puerto Rico, and planted along a road leading to the Insane Asylum near our laboratory. One specimen was planted near a shed which is used for storing timber. Since this timber came from an infested zone, we asked our collaborator Mr. Elías Vicente, to examine it for *Nectrias*. Not only did he find plenty of them, but he also called our attention to the fact that the *Poinciana* which was growing nearby, was beginning to show symptoms of a disease similar to that attacking coffee and *Gliricidia*, namely: defoliation, drying up and blackening of the branch tips, and black streaks along the vascular region. We proceeded to dig out and wash several roots. Upon examining them we found that they exhibited bark lesions. Out of 20 cultures made in sugar agar Petri dishes, 17 of them showed a *Fusarium* which had all the characteristics of *F. anisophilum*.

Infection was possibly due to the proximity of the tree to the infected wood pile, since the other *Poinciana* trees are still healthy.

Control Measures:

Studies on the life-history of the pathogene makes us advocate the following control measures:

1. In infested regions, the seed beds should be made in as poor a soil as possible with the idea of obtaining by natural selection, only those plants which survive because of unusual resistance.

2. In new plantings, the use of shade trees susceptible to the disease, should be discontinued.

3. Prune and burn all dry twigs and branches, from coffee shrubs and shade trees alike.

All these protective measures should be adopted simultaneously, and legislation to that effect should be passed. Any source of in-

fection which is not destroyed might result in the spread of the disease by the wind, and the infection of the soils.

Acknowledgments.—Before bringing this paper to an end, the author wants to express his indebtedness to the laboratory staff for their helpful collaboration; to Mr. Ingo H. da Silveira-Grillo for his valuable information about the ***Fusariums*** attacking coffee in Brazil; to Mr. Bienvenido Matienzo of the Department of Agriculture and Commerce of Puerto Rico for his helpful suggestions in gathering the bibliography; to D. Elías Vicente for his devoted help; to Mr. Arturo Roque, Assistant Phytopathologist of the Insular Experiment of Puerto Rico for translating the manuscript into English and to the Insular Experiment Station of Río Piedras, Puerto Rico. for publishing the paper.

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Explanation of Plates

Plate XLIX

Fig. 1. New shoots die back producing abnormal forms.

Fig. 2. Abandoned tree, top dead, abnormal branches arising from below.

Fig. 3. Plant attacked while bearing its crop.

Plate L

Fig. 4. Plants in "butterfly" stage. Plant at extreme right was punctured. Note retarded growth.

Fig. 5. One year old plant on inoculated soil showing lesions along stem.

Fig. 6. Splitting of the stem.

PLATE LI

Fig. 7. Root proliferation following destruction of normal roots by *F. anisophilum.*

Fig. 8. Inoculated kidney beans showing canker. Check in the middle.

PLATE LII

Fig. 9. (*a*) Conidiophores bearing microconidium and macroconidia. (*b*) Perithecia. (*c*) asci, paraphyses and (*d*) spores of *N. anisophila.*

PLATE XLIX

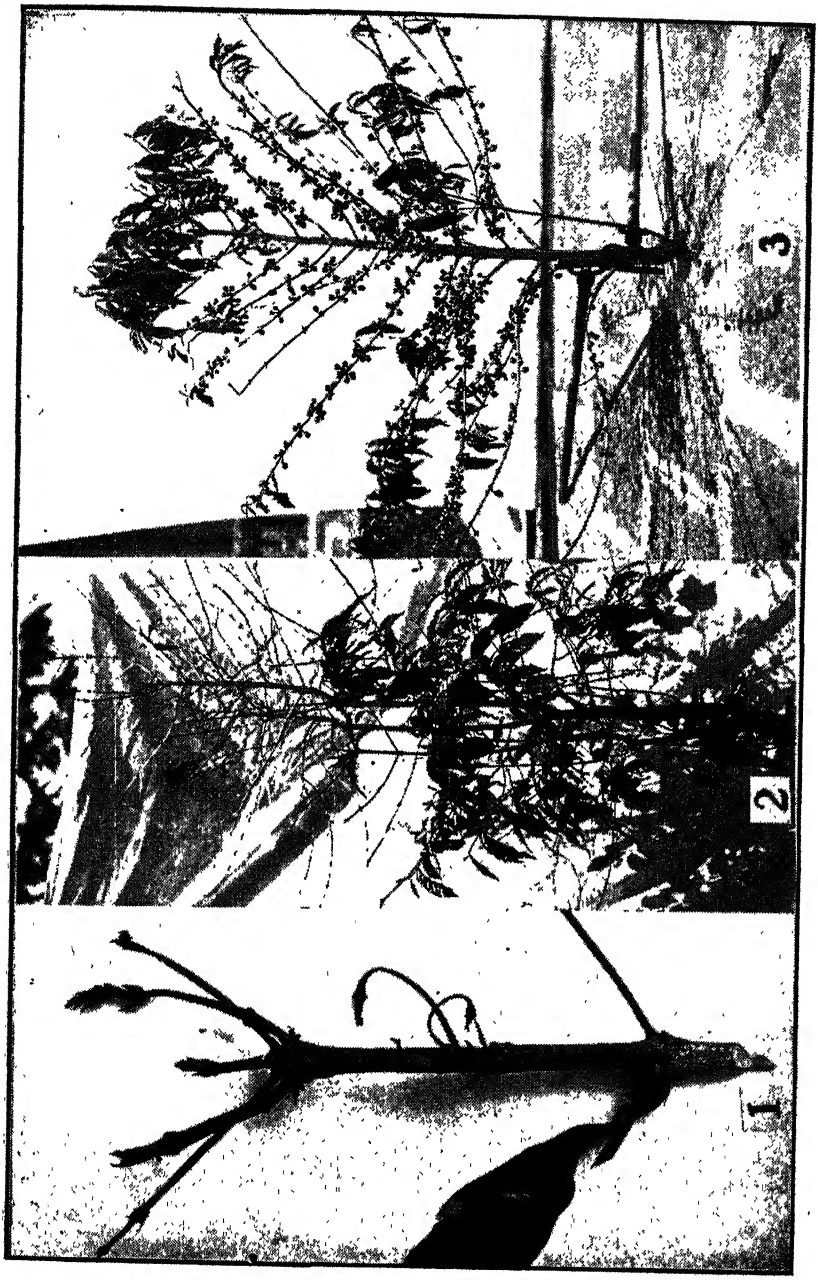


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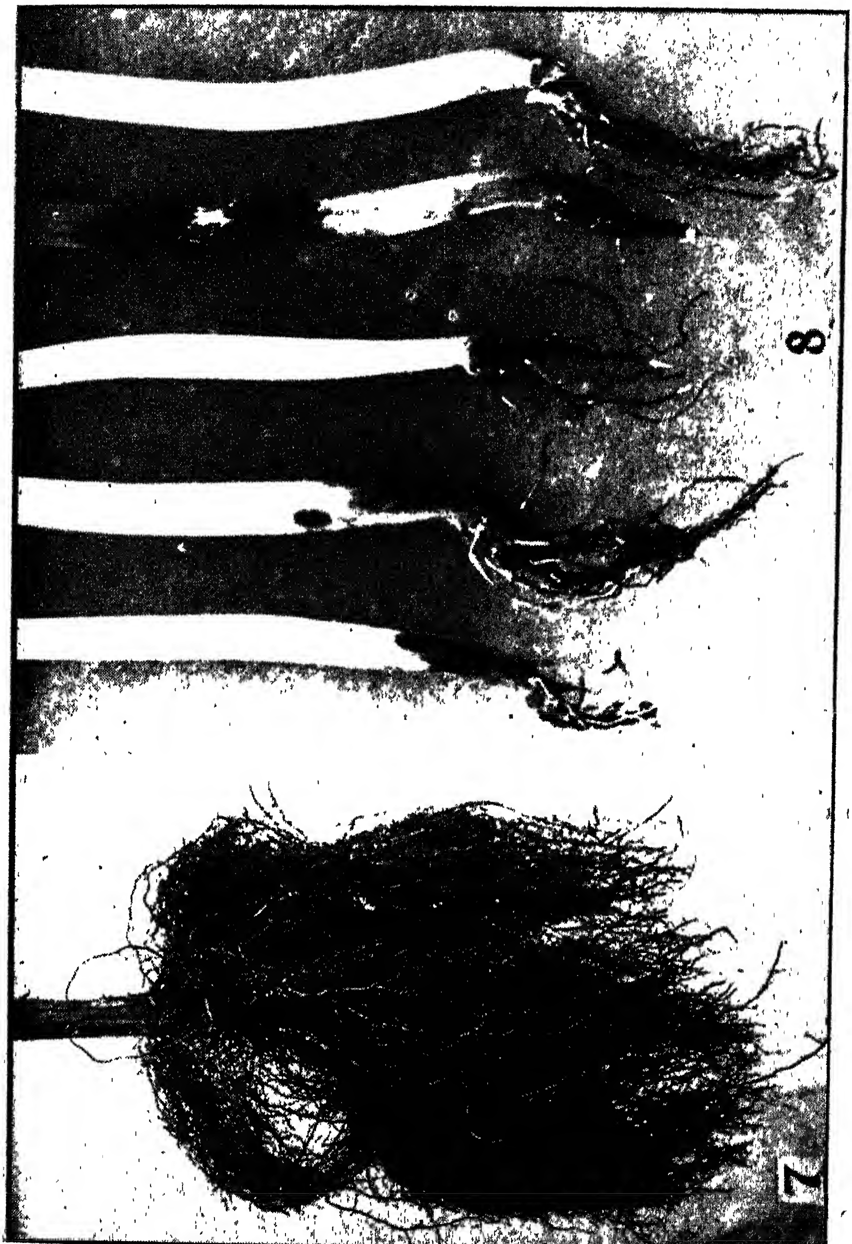
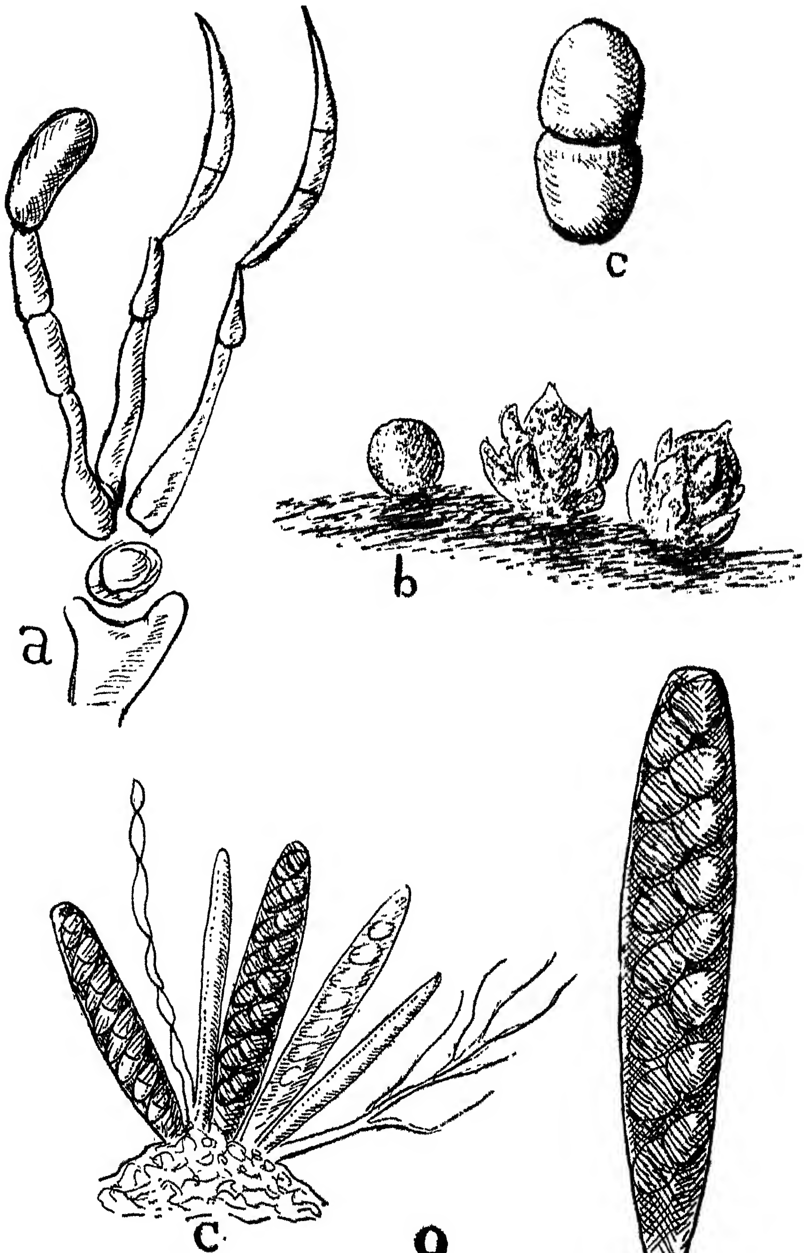
PLATE LI

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THE GROWTH OF HERPETOLOGY IN THE PUERTO RICO AND VIRGIN ISLAND AREA

CHAPMAN GRANT, *Major, U. S. Army.*

The earliest writers, Navarette, Oviedo, Casas and Herrera, writing in the latter part of the 15th century make no mention of our reptiles, according to de Armas in his "La Zoologica de Colon y de los Primeros Exploradores de America". They mention reptiles in Santo Domingo and on the Costa Firme only.

1654. Dutertre treats of the reptiles and amphibians of the Lesser Antilles and the Virgin Islands as a whole. He was probably plagiarized by de Rochefort in 1658 and later. Their description of the iguana; its habits and its use by the indians is graphic and probably authentic.

1788. Fra Inigo Abbad y Lasierra speaks of three species as occurring in Puerto Rico. This is the first mention of Puerto Rican reptiles.

1793. H. West wrote on the reptiles of St. Croix and St. Thomas, listing 7 species.

1796–98. Mr. Andre-Pierre Le Dru, a botanist, recorded 12 species from Puerto Rico, but no scientific cognizance is given to his herpetological work.

1863. J. Reinhardt and C. F. Leuthen published the first list of any scientific value, recognizing 10 species of reptiles and amphibians.

1868. E. D. Cope listed 15 species from Puerto Rico.

1876. W. Peters recognized 21 species.

1882. Agostin Stahl published his Catalogue. At this time 23 species were known.

1904. Dr. Leonard Stejneger recorded 35 species in a most scholarly work.

1928. K. P. Schmidt and in 1930 Thomas Barbour recognized 43 species from the Puerto Rico Area and an additional 10 from the Virgin Islands.

1932. The present list comprises 62 species from the Puerto Rico Area and 28 from the Virgin Islands of which 13 species occur on parts of both groups; a total of 77 species exclusive of marine turtles, but inclusive of extinct and introduced forms. The writer has described 11 new species in this Journal, one in Copeia and several remain to be described in my collection of 7,200 specimens.

KEY TO THE FOLLOWING LISTS:

n — New species described by the writer.
f — First local record of a known species.
r — Reestablished as a valid species.
z — Extinct locally or wholly.
? — Local occurrence questioned. If in first column the validity of species is questioned.
i — Introduced.

Some of the data in the following lists was kindly furnished by Miss Doris Cochran.

Herpetological list of species from the Puerto Rico Area			Mona	Puerto Rico	Vieques	Culebra	Virgin Islands
Bufo lemur	Cope	1868		x			
B. turpis	Barbour	1917					x
B. marinus i	Linnaeus	1758		x i			
Leptodactylus albilabris	Gunther	1859		x 1.	x	x	x
L. Fallax i	Muller	1923		x 2 i			
Eleutherodactylus portoricensis	Schmidt	1927		x 3			x f
E. gryllus	Schmidt	1920		x			
E. locustus	Schmidt	1920		x			
E. cramptoni	Schmidt	1920		x			
E. antillensis	R. & L.	1863		x	x	x	x
E. brittoni	Schmidt	1920		x			
E. wightmani	Schmidt	1920		x			
E. richmondi	Stejneger	1904		x			
E. monensis	Meerwarth	1901	x				
E. unicolor	Stejneger	1904		x			
E. karlschmidti	Grant	1931		x n			
E. cochranae	Grant	1932					x n
E. cooki	Grant	1932		x n			
E. lentus	Cope	1862					x
Hemidactylus brookii	Gray	1814		x f 4			
H. mabouia	Jonnes	1868			x f		x
Thecadactylus rapicaudus	(Houthuyn)	1782					x
Phyllodactylus pulcher	Gray	1830		x f			
Sphaerodactylus grandisquamis	Stejneger	1904		x r			
S. macrolepis	Gunther	1859					x 5
S. klauberi	Grant	1931		x n			
S. roosevelti	Grant	1931		x n	x n		
S. nicholsi	Grant	1931		x n			
S. townsendi	Grant	1931		x n	x n		
S. danforthi	Grant	1931			x n	x n	
S. monensis	Meerwarth	1901	x r				
S. gaigeae	Grant	1932		x n			
Iguana iguana i.	Linnaeus	1758					x i
Anolis cuvieri	Meerem	1820		x	x		x ?
A. roosevelti	Grant	1931				x n	
A. cristatellus	D. & B.	1837		x	x	x	x
A. acutus	Hallowell	1856					x
A. gundlachi	Peters	1871		x			
A. stratulus	Cope	1861		x	x	x	x
A. evermanni	Stejneger	1904		x			
A. pulchellus	D. & B.	1837		x	x	x	x
A. krugi	Peters	1871		x			
A. poncensis	Stejneger	1904		x			
A. monensis	Stejneger	1904	x r				
A. newtonii ?	Gunther	1859					x
Cyclura stejnegeri	Barbour & N.	1916	x				
C. mattea Z.	Miller	1918					x z
C. portoricensis Z.	Barbour	1919		x z			
C. pinguis	Barbour	1916					x
Celestus pleii	D. & B	1839		x			
Ameiva wetmorei	Stejneger	1904		x			
A. eleanorae	Grant & Roosevelt	1931		x 6 n			
A. polops	Cope	1862					x
A. exsul	Cope	1862		x	x	x	x
A. alboguttata	Boulenger	1896	x				
A. birdorum	Grant	1932		x n 7			
Amphisbaena caeca	Cuvier	1829		x			
A. fenestrata	Cope	1861					x
A. bakeri ?	Stejneger	1904		x			
Mabuya sloanii	Daudin	1803		x			
M. semitaeniatus	Wiegmann	1837	x r		?	x r	x r
Typhlops sp. 8	Shaw	1802		x	x f	x f	
T. richardii	D. & B.	1844					x r
T. monensis ?	Schmidt	1926	x				
T. rostellatus	Stejneger	1904		x			
Epicrates inornatus	Reinhardt	1843		x			
E. sp. 9	Grant	1932					x n
E. monensis	Zenneck	1898	x				
Dromicus stahli	Stejneger	1904		x			
D. exiguus	Cope	1862			?	?	x
Alsophis antillensis	Schlegel	1837			?	x	x
A. portoricensis	R. & L.	1863		x			
A. variegatus ?	Schmidt	1926	x				
A. sancti-crucis	Cope	1862					x
Pseudemys rugosa	Stahl	1882		x	x f		
P. descussata	Peters	1876		x			
Testudo tabulata i	Walbaum	1782		x z i			x i

Notes:

1. The Puerto Rico form seems to be distinct from that of the Virgin Islands.
2. Introduced by the Experiment Station of Mayagüez in 1929 again in 1932 from Dominica without evidence of establishment as yet.
3. I believe this name includes two species.
4. Misidentified by earlier writers as being *H. mabouia.*
5. This species has recently been confused with *S. grandisquamis* and *S. monensis.*
6. Known only from Caja de Muertos island.
7. Known only from Diablo Key off Fajardo.
8. This group of the genus is in need of revision. I hope to report on my series of over 100 from 7 islands.
9. To be described.

In the Virgin Island List:

St. Croix includes Buck Island.

St. Thomas includes; Water Island, Hassell Island, Buck Island Saba Island.

St. John includes; Congo and Lovango Keys.

St. James includes: Little St. James, Dog Island.

Tortola includes; Guana, Buck, Salt and Peter Islands.

Herpetological list of species from the Virgin Islands		St. Croix	St. Thomas	St. John	Virgin Gorda	Anegada	St. James	Tortola	Just Van Dyke
Bufo turpis	Barbour..... 1917.				x				
Leptodactylus albilabris	Gunther.....1859.	x	x	x f		x		x	x
Eleutherodactylus lentus	Cope...... .1862.	x	x						
E. antillensis	R. & L......1863.		x	x f				x	
E. portoricensis	Schmidt.....1927.			x f				x f	
E. cochranae	Grant ....1932.		x n	x n					
Hemidactylus mabouia	Jonnes.......1868.	x	x	x				x	x
Thecadactylus rapicaudus	(Houttuyn)..1782.	x	x						
Sphaerodactylus macrolepis	Gunther.....1859.		x	x f	x	x	x f	x	
Iguana iguana	Linnaeus.....1758.		x					x f	
Anolis cuvieri	Merrem......1820.							x ?	
A. cristatellus	D. &B.......1837.		x	x f	x	x	x f	x	
A. acutus	Hallowell....1856.	x							
A. stratulus	Cope.........1861.		x	x f				x	x
A. pulchellus	D. & B......1837.	x	x	x f	x	x	x f	x	x
A. newtonii ?	Gunther.....1859.	x							
Cyclura mattea	Miller........1918.		x z						
C. pinguis	Barbour......1916.					x			
Ameiva polops	Cope.........1862.	x							
A. exsul	Cope.........1862.	x ?	x	x		x f	x f	x f	
Amphisbaena fenestrata	Cope.........1861.	x	x	x				x f	
Mabuya semitaeniatus	Wiegmann...1837.	x	x	x ?				x f	x
Typhlops richardii	D. & B......1844.	x ?	x	x f				x f	
Epicrates sp.	Grant.........1932.							x n	
Dromicus exiguus	Cope.........1862.		x	x				x f	
Alsophis antillensis	Schlegel......1837.		x	x ?	x		x f	x f	
A. sancti-crucis	Cope.........1862.	x							
Testudo tabulata	Walbaum....1782.		x f	x f					

HERPETOLOGICAL NOTES

CHAPMAN GRANT, Major, U. S. Army

Aristelliger cochranae

Aristelliger cochranae was described as a new species in this Journal, Vol XV, pp. 399–400. Noble and Klingel have described a new genus in American Museum Novitates, No. 549, p. 4, under the name of *Aristelligella* to which they refer our new species.

Sphaerodactylus

The same authors, p. 11 et seq. describe a new *Sphaerodactyl* and in discussing variation and sexual differences state: ". . . We are indebted to Major Grant for his discovery of a reliable secondary sexual character of value in distinguishing sexes [the "escutcheon" of the male] . . . As a matter of practice we find the hypertrophy of these scales the [escutcheon] less diagnostic of sex than another male character which we believe has not been hitherto described. The posterior lip of the cloaca is very much broader in the *adult* male than in the *adult* female [italics mine] . . . The only adult males in our series which do not show this distinctive lip are not well preserved or are so bent that the cloacal lips do not meet in the normal way. In checking through the series of sphaerodactyls in the American Museum we find the lip less variable than the hypertrophied scales [escutcheon]."

My study of a series of 2,035 specimens of nine species from the Puerto Rico Area has shown that the escutcheon is visible in newly hatched specimens and not confined to "adults". We do not read in what way the escutcheon is "less diagnostic" than the character of cloacal lips found only in "adults" and invisible in "not well preserved" or "bent" specimens. We read that "the lip is less variable than the" escutcheon. The escutcheon is present regardless of variability on all males of whatever age, state of preservation or bending. Nothing is claimed for species occurring outside of the Puerto Rico Area.

Further we read: "Grant (1931) lays considerable emphasis on sexual dichromatism as a diagnostic species character in his sphaerodactyls from Puerto Rico and adjacent areas . . . In *inaguae*, [*S. inaguae*] we have been able to establish definitely that there is considerable variation in color, and the sexes of adults cannot always

be distinguished by difference in coloration . . . In view of the wide limits of variation in *inaguae,* it seems probable that other species of *Sphaerodactyls* are more variable than Grant and others have assumed.''

In my description of new species and rediscriptions of known species the following points have been brought out in various articles in this Journal:

There is no sexual dichromatism whatever at any age in *S. klauberi, nicholsi, townsendi, gaigeae* or *monensis.*

Sexual dichromatism is present and forms an *almost* infallible character in *adults* of *S. grandisquamis, macrolepis* and *danforthi.*

Sexual dichromatism most marked from newly hatched to adults in *S. roosevelti.*

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HERPETOLOGICAL NOTES

The Journal has published articles on a collection of 7,235 reptiles and amphibians collected during 1931–1932 in the Puerto Rico and Virgin Island Areas. The first articles appeared in the July, 1931 number; and in each succeeding number to date. The collection is now in the Museum of the University of Michigan.

ON THE LIFE-HISTORY AND SYSTEMATIC POSITION OF THE ORGANISMS CAUSING DRY TOP ROT OF SUGAR CANE

W. R. Ivimey Cook B. Sc., Ph. D.
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In 1920 Matz (**5, 6, 7**) described an organism which caused a disease of the sugar canes in Puerto Rico. He referred it to the genus *Plasmodiophora,* under the name *P. vascularum* Matz. In 1929 Dr. Melville T. Cook (**1**) made a further investigation and transferred the organism to the genus *Ligniera* on the grounds that since it caused no hypertrophy of the host tissue it should be relegated to that genus which was characterised by causing no hypertrophy. Certain peculiarities described by Dr. Cook made me doubtful if this organism was really a species of the genus *Ligniera,* and induced me to write to Dr. Cook and ask him if he would send me a specimen slide in order to compare it with the other species of the genus with which I was familiar. In reply Dr. Cook sent me all the slides he had and was kind enough to invite me to make what use I cared of the slides and to publish any results obtained in this journal. I very gladly accepted this kind offer as I at once saw that the organism differed very considerably from the other species of the genus *Ligniera,* and, in fact, from any of the species of the Plasmodiophoraceae which I had seen.

There are certain characteristics which, after a study of the Plasmodiophoraceae, one appreciates as always occurring in all the species. The most important is the appearance of the plasmodium. Even from the time when the nucleus of the original amoeba divides into two the most noticeable feature is the presence of the nuclei. Irrespective of what staining method is employed, the karyosomes of these nuclei stand out as deeply staining bodies, spherical in outline and surrounded at a little distance by a clearly defined nuclear membrane. The chromatin may not be so easily seen since it lies around the nuclear membrane, or it may be that it is the presence of the chromatin which makes the nuclear membrane stain up when a dye is employed. Whichever is the case, these nuclei stand out clearly in the plasmodium, and, in slides stained with Iron Alum and Haematoxylin the plasmodia appear as a greyish mass spotted all over with small black bodies. Division of these nuclei is rarely seen, and

stages in which there is any disappearance of the characteristic karyosome are so infrequent that in no slide would more than one per cent of the plasmodia show any other stage. Only when the plasmodia are mature does the karyosome disappear. but even there the nuclear membrane remains recognisable until chromatin again is seen in the nuclei. In Dr. Cook's slides, which were stained with various dyes, I was at once struck by the almost complete absence of any recognisable nuclei in the plasmodia. Dr. Cook noticed this himself and says in his paper (1) "Nuclei could not be seen in any of the preparations until the spores began to form and sometimes the nuclei were not visible even when spore formation was well advanced". This characteristic is unlike anything which I have seen in any of the species of the Plasmodiophoraceae which I have studied.

Being unable to reconcile the fungus with any of the other Plasmodiophoraceae, and finding it difficult to determine the systematic position of the organism present, I wrote again to Dr. Cook asking him for a supply of material fixed specially for me. Dr. Cook in reply sent me a quantity of material fixed in Bouin's Fluid which was made up as follows:

Formaldehyde (formalin)	25 parts
Picric acid (satur. aq. sol.)	75 parts
Acetic acid	5 parts

The material was sectioned after embedding in wax and serial sections from 6–10 μ in thickness were cut. These were then critically examined and compared with the slides previously sent me by Dr. Cook. At the same time I asked Dr. E. J. Butler F.R.S., of the Imperial Mycological Institute, Kew, to examine the slides and give me the benefit of his opinion on the parasite. In addition Mr. S. F. Ashby also examined and reported on the slides. Their observations agreed with the conclusion which I had also arrived at, namely that more than a single organism was present in the diseased canes. and I now propose to consider in detail the results of my study of the disease.

There are three distinct types of spherical or subspherical bodies present in the cells. The largest and most conspicuous are thin walled and in some slides frequently collapsed bodies 16–21 μ in diameter (Pl. LIII fig. A). These occur almost exclusively in the larger vessels and are frequently developed in such numbers that they completely block the whole of the passage. The second type are smaller, measuring 14–16 μ in diameter. These have thicker walls which are double-contoured and contain a definite nucleus in which one or sometimes two nucleoli can be made out. They are not so frequent

and are rarely found in the large vessels though they may occur in the phloem or sometimes in the xylem parenchyma or even in the cortex. From their size and structure they correspond to the spores of *Ligniera vascularum* described by Dr. Cook. The third spore type is somewhat irregular in shape, measuring from 10–12 μ in diameter, and when fully grown is seen to be made up of a number of small spherical bodies each containing a well-marked nuclear mass which stains up clearly.

In addition to these there appear two distinct types of amoeboid material from which the spore types are differentiated. The most recognisable type consists of large masses which despite repeated staining by various aniline dyes fail to shew any recognisable structure or nuclei (Pl. LIII fig. D). These correspond to Dr. Cook's plasmodia. They are restricted to the large vessels and also definitely form part of a life-cycle with the largest spore type since it has been found that the latter become differentiated from them. The second amoeboid structure consists of much smaller elements, which are restricted to the phloem and xylem parenchyma. These, shewing structure and nuclei with a single well-defined nucleolus, have been repeatedly observed.

Finally there are present minute spherical bodies which stain very deeply. These frequently appear associated with the three other spore types and Mr. Ashby thinks that they are probably bacteria.

There seems no question that the organism which is chiefly responsible for the disease of Dry Top Rot of Sugar canes is this large amoeba and its associated large spore type, and I will first give an account of its life history. I propose to call it *Amoebosporus vascularum.*

The Life-History of Amoebosporus vascularum sp. nov.

The amoeba, in the earliest stage found, consists of a uniform mass of protoplasm in which no differentiation of any kind is apparent. The protoplasm appears granular after fixation, whether fixed with Bouin's Fluid or with Flemming's solution. No nuclear structure could be seen in any of the preparations whatever dye had been used to stain it. These amoebae occur in the spiral and annular tracheids and in the pitted vessels of the vascular bundles. As they increase in size the amoebae as a rule do not shew any further differentiation (Pl. LIV fig.), but occasionally the protoplasm develops vacuoles (Pl. LIV fig. 4). When mature the amoebae completely fill the vessel in which they have been growing and it appears that this acts as a stimulus for reproduction. The protoplasm

becomes traversed by lines in which solid material is laid down. From this the walls of the large spherical cysts, already referred to, (Pl. LIV fig. 6), are formed. These cyst are, at first, spherical and contain a single nucleus. This is generally the first stage in which nuclei become clearly recognisable. It is possible in the early stages in cyst development, to stain them sufficiently to see something of their internal structure. The nucleus is central, surrounded by a granular cytoplasm in which highly refringent granules are present. These are not dissolved by dilute hydrochloric acid and appear to consist of silicates. After a time the nucleus divides into a number of parts and around each a small spherical mass of protoplasm is formed and a cell wall is secreted. These bodies are difficult to see since the wall of the cyst has by this time become hard and stains do not penetrate easily (Pl. LIII fig. B). There is no doubt, however, that spores are formed (Pl. LV fig. 8). Whether the cyst breaks at once or remains intact for some time could not be determined, but eventually the spores are shed and come to lie around the empty cysts, Pl. LV fig. 7. During the formation of the cysts all the protoplasm of the amoeba is not used up, (Pl. LIV fig. 5), and after the discharge of the spores much cytoplasm is found lying around them, so that they come to be embedded in the protoplasm of the original amoeba (Pl. LV fig. 7).

The germination of the spores is difficult to observe, and the author is not certain that the following stages form part of the same life-cycle. As far as he can see the spores germinate to produce a small spherical body containing a clearly marked nuclets (Pl. LIV fig. 1), in which there is a vacuole associated with the nucleus. The protoplasm later becomes more vacuolated as the amoeba grows (Pl. LIV fig. 2). The sequence of stages shewing the development between that represented by Pl. LIV fig. 2 and Pl. LIV fig. 3 have not been found, but the author is quite certain that the large amoebae found are derived from these small bodies.

The life-cycle of this organism may be graphically represented by the following diagram:

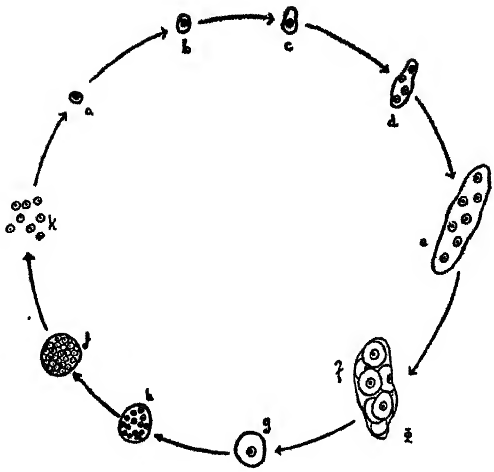

Diagram of Life-cycle of *Amoebosporus vascularum.* *a.* spore; *b.* germinated spore; *c. young amoeba*; *d.* multinucleate amoeba; *e.* mature amoeba; *f.* formation of cysts within amoeba; *g.* single cyst; *h.* multinucleate cyst; *j.* formation of spores within cyst; *k.* separation of spores.

THE LIFE-HISTORY OF AMOEBOSPORUS SACCHARINUM SP. NOV.

The life-history of the second organism present is in many respects similar to the first, but it differs chiefly in the smaller size of the amoebae, cysts and spores. Moreover it does not appear to be of great economic importance since there is little evidence that it seriously affects the host. It is proposed to call this *Amoebosporus saccharinum.*

The earliest stage found consists of uninucleated amoebae which occur in some of the cortical cells as well as in the phloem and xylem parenchyma, but never in the xylem vessels. These amoebae are irregular in shape and are composed of very fine granular protoplasm quite distinct in character from that in *A. vascularum.* There is a central nucleus with a nucleolus lying in its centre. The nucleus divides by a process which appears to be mitosis, though insufficient stages were seen to determine this point with certainty. Concurrently with nuclear division the amoeba increases in size (Pl. LV figs. 10–12). Large plasmodia were not found though those containing up to six or seven nuclei occurred. The amoebae finally became surrounded with a cyst wall and the contents divided up into a number of small

spherical cells each of which contained a single nucleus. (Pl. LV fig. 13). Pl. LV fig. 14 shews one in which the cyst has split and the contents migrated out into the surrounding cell. Fixation must have occurred during this process, since, while some of the spores remain within the cyst, others have already left it. As far as could be made out these bodies are provided with an apical flagellum, and at this early stage are pyriform in shape, though later they became rounded. There is a single nucleus which is situated either in the centre or towards the anterior end. The development of a flagellum does not take place until after the spores have left the cyst, and then not in every instance. In the majority the spores resemble those of *A. vascularum* in character but are smaller in size.

A third type of spore-like body was found in some of the cells which is represented in Pl. LV fig. 16. These bodies may be connected with one of the life-cycles described but it seems very improbable. They occur relatively rarely and may represent a stage in the life history of some other organism. The bodies are spherical, with a double wall of appreciable thickness, and contain a single dark staining body which appears to be a nucleus. No stage in their further development has been seen.

Discussion

It has been a matter of considerable difficulty to separate these two organisms, and only the culture of the two organisms separately on artificial media would prove conclusively that their life-histories are correct. Since I was working so far from the actual locality in which the disease occurred it was impossible for me to attempt to carry out such experiments, and I have had to rely exclusively upon a study of fixed material.

Assuming that I have made no mistake in the life-histories which I have indicated, it will be seen that neither organism bears any relationship with the Plasmodiophoraceae. With the exception of those stages represented in Pl. LV figs. 9–12 there is nothing which shews any similarity to any species of the Plasmodiophoraceae now recognised (2).

In the structure of the protoplasm and in the general appearance these two organisms undoubtedly belong to the Rhizopoda. Many Protozoa occur in plant tissue, though a critical study of them has not been made. In a recent paper (3) a short account has been given of one living in the roots of *Apium nodiflorum,* though in this instance the cysts have not been found to divide up into spores. These Protozoa occur in plants living in damp or badly drained soil.

In *Apium nodiflorum* only plants growing by the side of a lake in a very marshy soil have been found to contain these amoebae. In the present instance it has been recorded that the disease is most common in low-lying badly drained soil (**1**). Such a position would be suitable for the development of saprophyte soil-inhabiting amoebae, which have become secondarily modified as parasites in plant tissue. I have been unable to determine the precise pathological effect which these organisms produce in the host, but, as Dr. Cook points out, the quantity of the organism is not sufficient to explain the effect by assuming that it merely causes a blocking of the larger xylem vessels. It has been repeatedly noticed that there is a marked tendency for the vessel to break during sectioning at a point where the parasite is developing which seems to indicate that an alteration has been produced in the material composing the cell wall, and that therefore the organism is not living merely as a saprophyte in the vessels. This is further confirmed by slight changes in the reactions to stains which is exhibited by these areas.

These organisms have been previously regarded as a single species under the name *Plasmodiophora vascularum* and *Ligniera vascularum* and although there are stages in the life-cycles which have not been completely investigated it seems desirable to give them scientific names since they are of definite economic importance to sugar canes in Puerto Rico. It is therefore proposed to place them in a new genus under the descriptive name *Amoebosporus.* The larger and more important will be called *Amoebosporus vascularum,* since it lives chiefly in the xylem vessels; and the smaller will be called *Amoebosporus saccharinum.* As regards their systematic position, the presence of amoebae and also cysts suggests relationship with the Rhizopoda and in particular with the family Lobosa in which pseudopodia are short, blunt, or absent. It is proposed, therefore, to place this new genus provisionally in that Family.

SYSTEMATIC DIAGNOSIS

The following Latin diagnoses of the new genus and the two species have been prepared.

Amoebosporus–gen. nov.

Amoebae quibus in cellulis hospitis cystes formatae sunt. Cystes in multis sporis dividiuntur. Sporarum amoebae formatae. In radicibus et caudicibus plantarum palustrium.

1. *A. vascularum* sp. nov.

Syn. *Plasmodiophora vascularum* Matz. pr. p.

Amoebae magnae. Cystes 16–22 μ diam. In cellulis lignis hos-

pitis formatae sunt. Cystes in sporis dividiuntur. Sporae 2–3 μ diam. Sporae in amoebis pariuntur.

Hab. In radicibus et caudicibus *Saccharum officinari* in Porto Rico, West Indies.

2. *A. saccharinum* sp. nov.

Syn. *Plasmodiophora vascularum* Matz. pr. p.

Amoebae minutae. Cystes 10–12 μ diam. In cellulis phloemis et corticis hospitis formatae sunt. Cystes in sporis dividiuntur. Sporae 1.5–2 μ diam. Sporae in amoebis pariuntur.

Hab. In radicibus et caudicibus *Saccharum officinari* in Porto Rico, West Indies.

I wish to record my grateful thanks to Dr. Melville T. Cook for the very willing assistance which he has given me both by the loan of slides and also in collecting and fixing suitable material. I am also indebted to Dr. E. J. Butler, F.R.S. and Mr. S. F. Ashby of the Imperial Mycological Institute, Kew, for their assistance in examining and reporting upon some of the microscopic preparations.

February 1932.

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DESCRIPTION OF PLATES

The drawings were made with a camera lucida at table level, with tube length 160 mm. using a Zeiss 2 mm. (N. A. 1.4) objective and compensating ocular × 15 (Fig. 1–2, 8), compensating ocular × 7 (Figs. 3, 9–15) and compensating ocular ×15 (figs. 4–7, 16)

The photomicrographs were made a Zeiss 4.2 mm. (N. A. 0.65) objective. The drawings and photographs have been reproduced

without reduction, and actual magnifications are given after the description of each figure.

PLATE LIII

Fig. A.—A photomicrograph of *A. vascularum* shewing a mass of the cysts lying in a large xylem vessel. × 100

Fig. B.—A photomicrograph of a small number of cysts of *A. vascularum* showing the division of the contents into separate spores. × 750

Fig. C.—A photomicrograph of a transverse section through a vascular bundle showing the cysts in the central vessel surrounded by amoebae of *A. vascularum*. × 300.

Fig. D.—A photomicrograph of a large xylem vessel showing the presence of a mature amoeba of *A. vascularum* lying within it. × 900

PLATE LIV

Figs. 1–8.—*Amoebosporus vascularum*.

Fig. 1.—The spores after escape from the cyst showing the nucleus and associated vacuole. × 2475

Fig. 2.—A later stage in the development of the spore after liberation into the vessel. The contents are becoming vacuolate, and the nucleus less distinct. × 2475

Fig. 3.—A large amoeba lying in and completely filling a large vessel shewn in tranverse section. The amoeba at this stage does not shew any internal structure. ×1155

Fig. 4.—A drawing of a large vascular strand shewing the presence of amoebae in several of the vessels. Three amoebae are present in the largest vessel one of which is shewing vacuolation. × 825

Fig. 5.—A large amoeba in longitudinal section shewing the formation of cysts from within the amoeba. These cysts are now empty and some of the spore from them are seen lying in the upper part of the amoeba. × 825

Fig. 6.—Four cysts shewing an early stage in the division into spores. The nuclei are visible. × 825

PLATE LV

Fig. 7.—Part of a large amoeba containing both cysts and spores. The cysts are empty and their contents have passed out into the surrounding protoplasm which has not been involved in cyst formation. × 825

Fig. 8.—A large mature cyst just before breaking. Shewing the contents divided up into a large number of spores each of which has a well-marked nucleus. $\times$ 2475

Figs. 9–16.—*Amoebosporus saccharinum.*

Fig. 9.—A very young amoeba in which the protoplasm is just becoming differentiated. $\times$ 1155

Fig. 10.—A slightly older amoeba developing within a small cell of the xylem parenchyma. $\times$ 1155

Fig. 11.—An amoeba after the nucleus has begun to divide up. This amoeba was growing in the phloem tissue. $\times$ 1155

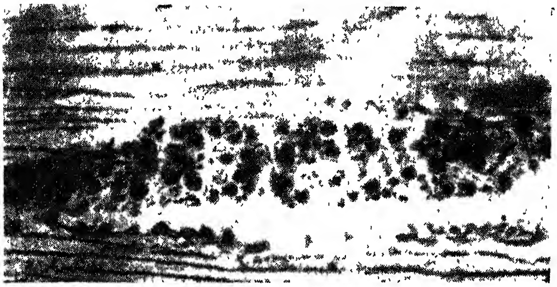
Fig. 12.—An older amoeba with six nuclei developing in a cell of the phloem tissue. $\times$ 1155

Fig. 13.—A late stage in the formation of cysts from the amoeba, shewing the contents dividing up prior to fragmentation. $\times$ 1155

Fig. 14.—A cyst lying apparently quite free in a xylem vessel. The cyst has broken and some of the contents has escaped into the surrounding tissue. These spores appear to possess a single flagellum. $\times$ 1155

Fig. 15.—Two young spores after escape and migration into the cortical tissue. The nucleus is clearly seen and the flagellum was visible. $\times$ 1155

Fig. 16.—Spherical spores lying in a cell of the cortical parenchyma. It is doubtful if these represent a stage in either of the species described. $\times$ 825



A

B

C

D

PLATE LIV

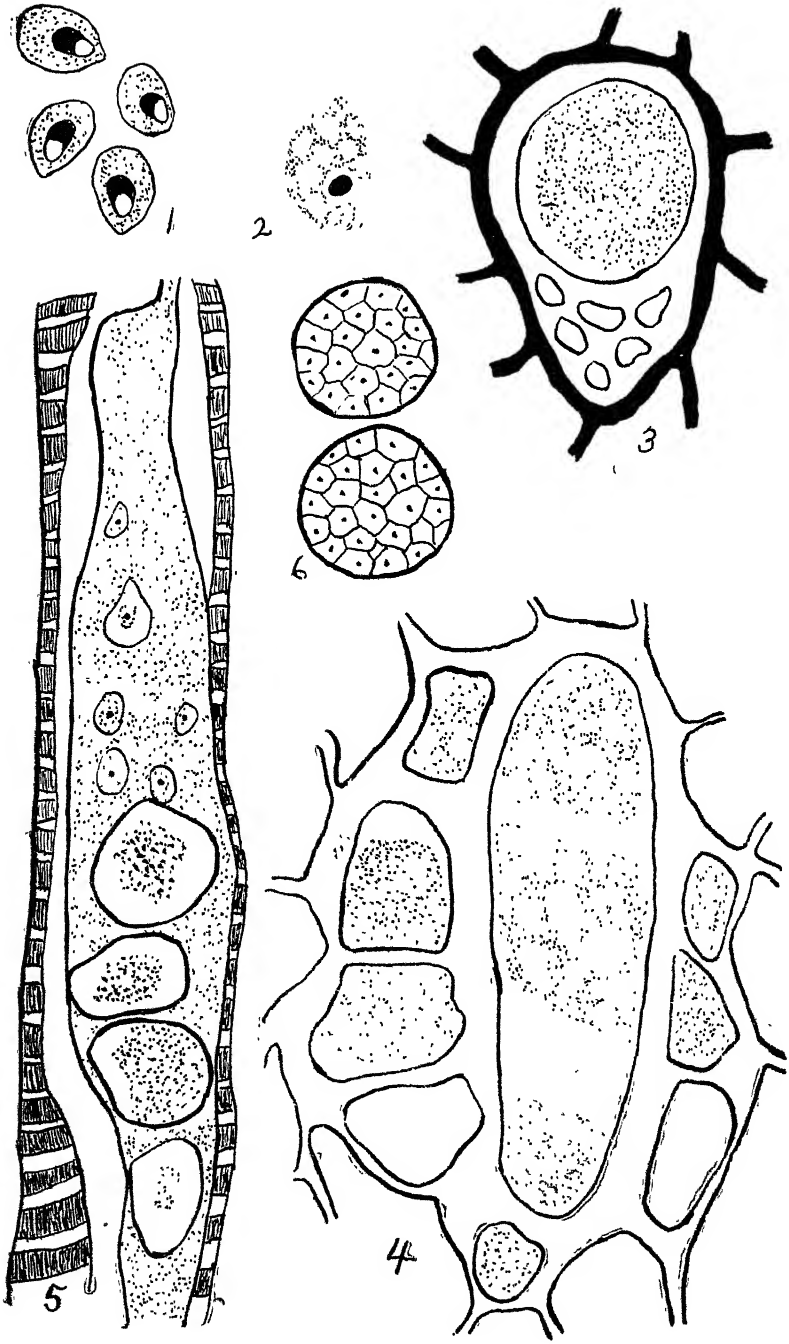
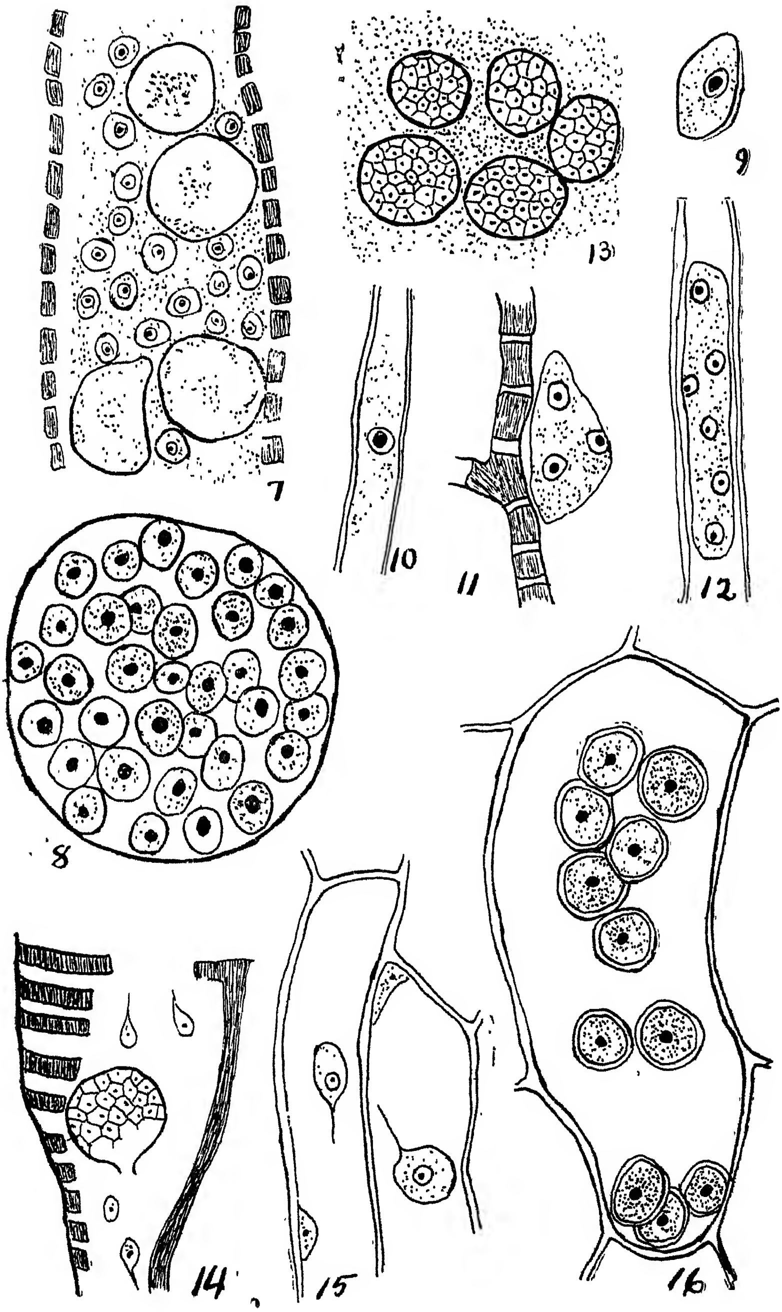


PLATE LV



INTRODUCTION OF LEPTODACTYLUS FALLAX IN PUERTO RICO

T. B. McClelland, Director,
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The Federal Experiment Station of Mayagüez has made two importations of *Leptodactylus fallax,* the "mountain chicken" or large edible frog of Dominica, with the object of establishing this species in Puerto Rico.

The first lot of 12 frogs was received from Dominica July 1929. They were released on the shore of the Cartagena Lagoon, a location which had proved highly favorable for the development of the toad, *Bufo marinus,* introduced by the station in 1920 from Barbados. Whether or not the frogs persisted is not known. Later attempts to definitely locate them failed.

In June of the present year a second and larger lot was imported from the same source. Ninety individuals were received alive. Fifty were released on the bank of the reservoir located on the station farm just north of Mayagüez, and forty were released on the river bank near Las Vegas.

Their loud call from one point or another on the station grounds was frequently heard at night thereafter, and in November a young frog of this species was found.

This species is shown in colors in the National Geographic Magazine, May, 1932 and under the plate is the legend: An Edible Species In Some Danger of Extermination. Let us hope that its introduction into Puerto Rico may not reduce the danger of extermination, but that it may also supply the Island with an epicurean dish not previously procurable.